

**Ukrainian Scientific  
and Practical  
Conference**

The logo for the Scientific Research Methodology (SRM) conference. The letters 'SRM' are rendered in a large, bold, black sans-serif font. Surrounding the letters is a network diagram consisting of several colored nodes (red, blue, yellow, orange) connected by thin lines, suggesting a complex or interconnected system.

**SRM**

**«Scientific Research  
Methodology – 2024»**



**November, 2024**

# Proceedings

## Ukrainian Scientific and Practical Conference

# Scientific Research Methodology – 2024



**Editor-in-Chief:** Doctor of Technical Sciences, Professor, **Constantine BAZILO**  
**In charge for the issue:** Ph.D., Assistant, **Anna TOPTUN**

### Organizing Committee

**Oleg GRYGOR**, Doctor of Political Sciences, Professor, Cherkasy State Technological University (ChSTU), Cherkasy  
**Emil FAURE**, Doctor of Technical Sciences, Professor, Cherkasy State Technological University (ChSTU), Cherkasy  
**Maksym BONDARENKO**, Doctor of Technical Sciences, Professor, Cherkasy State Technological University (ChSTU), Cherkasy  
**Constantine BAZILO**, Doctor of Technical Sciences, Professor, Cherkasy State Technological University (ChSTU), Cherkasy  
**Vyacheslav TUZ**, Candidate of Technical Sciences, Associate Professor, Cherkasy State Technological University (ChSTU), Cherkasy  
**Liudmyla USYK**, Candidate of Philological Sciences, Associate Professor, Cherkasy State Technological University (ChSTU), Cherkasy  
**Anna TOPTUN**, Ph.D., Assistant, Cherkasy State Technological University (ChSTU), Cherkasy

### Conference research topics

- Theoretical and Methodological Foundations of Scientific Research
- Interdisciplinary Research Methodology
- Methodological Aspects of Innovative Technologies
- Empirical Methods in Scientific Research
- Ethical and Legal Aspects of Scientific Research

### The Ukrainian Scientific and Practical Conference "Scientific Research Methodology – 2024"

The Ukrainian Scientific and Practical Conference "Scientific Research Methodology – 2024" provides a platform for multi-dimensional discussions on theoretical concepts and methods in modern scientific research, approaches and integrated methods deployed in various scientific disciplines to solve complex problems, state-of-art methods and tools for investigating latest technologies and their impact on scientific activity, quantitative and qualitative methods of data collection and analysis in various scientific disciplines, and legal aspects related to intellectual property and research publications.

### Address (Organizing Committee)

Ukraine, 18006, Cherkasy,  
Shevchenko Blvd., 460,  
Cherkasy State Technological University (ChSTU),  
IMCT Department  
SRM-2024 Organizing Committee

Approved by the Academic Council of  
Cherkasy State Technological University,  
Protocol 4 of November 25, 2024

### Articles are published in the author's original version.

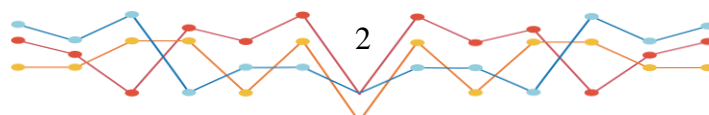
The editorial board's vision does not always coincide with the authors' position.

The authors of the published materials bear full responsibility for the selection and accuracy of the facts and quotes provided, economic, statistical, and technical data, proper names, and other information presented.

The editorial board is not responsible for the accuracy of the submitted material but reserves the right to abridge and edit the submitted materials to be optimally presented to the readers.

CONTENTS

<b><u>R. Titorenko, V. Tychkov, R. Trembovetska, V. Halchenko</u></b>	
<i>QUALITY CONTROL SYSTEM FOR ANTICORROSIVE COATINGS OF STEEL PRODUCTS</i>	5
<b><u>O. Zrazhevskiy</u></b>	
<i>MITIGATING EXPLOITATION OF SOFTWARE VULNERABILITIES IN PROGRAMMING LANGUAGE INTERPRETERS</i>	7
<b><u>A. Yaroslavskiy</u></b>	
<i>APPLICATION AND MATHEMATICAL MODELING OF PIEZOCERAMIC ELEMENTS FOR INDUSTRY</i>	10
<b><u>O. Yalynskiy</u></b>	
<i>MODERNIZATION OF THE ENERGY SYSTEM OF UKRAINE</i>	16
<b><u>R. Lutsenko</u></b>	
<i>INTELLIGENT DATA ANALYSIS SYSTEMS FOR RESEARCH IN BEHAVIORAL ECONOMICS OF VIRTUAL ASSETS</i>	19
<b><u>O. Protsenko</u></b>	
<i>METHODOLOGY FOR ENSURING CYBER RESILIENCE IN THE CLOUD ENVIRONMENT AT THE ENTERPRISE</i>	22
<b><u>V. Shymko, V. Dudka, A. Toptun</u></b>	
<i>ANALYSIS OF THE EFFECT OF AIR POLLUTION ON THE CONDITION OF HUMAN HAIR BY SCANNING PROBE MICROSCOPY</i>	25
<b><u>O. Filimonova, S. Filimonov</u></b>	
<i>MUSCLE FOR A FLYING MINIROBOT</i>	28
<b><u>O. Myhal</u></b>	
<i>IMPROVING THE ENERGY EFFICIENCY OF THE SUPPLY SYSTEM OF COMPRESSED AIR</i>	31
<b><u>Y. Korolkov</u></b>	
<i>REACTIVE POWER COMPENSATION FOR RESIDENTIAL CONSUMERS</i>	35
<b><u>B. Yakovlev</u></b>	
<i>LEVERAGING ZABBIX FOR CYBERSECURITY</i>	37
<b><u>V. Samsonenko, V. Palahin, O. Palahina</u></b>	
<i>INTEGRATION OF COMPUTER VISION INTO ROBOTIC TECHNICAL SYSTEMS USING THE YOLO PLATFORM</i>	40
<b><u>A. Grushnitskiy, V. Palahin</u></b>	
<i>DEVELOPMENT OF AN END-TO-END ENCRYPTED MESSAGING CHATBOT</i>	43
<b><u>B. Bielkov, V. Palahin, O. Palahina</u></b>	
<i>DEVELOPMENT OF AN ANTI-SPOOFING METHOD FOR IMAGES IN BIOMETRIC SECURITY SYSTEMS USING ML</i>	46
<b><u>D. Hrebeniuk</u></b>	
<i>UTILIZING RUBY FOR MACHINE LEARNING WORKFLOWS</i>	48
<b><u>R. Ptashkin</u></b>	51



FORENSIC EXAMINATION OF OBFUSCATED CODE

<b><u>V. Simonov</u></b>	
METHODOLOGY FOR INFORMATION LEAK RESEARCH	54
<b><u>V. Chornodobravska</u></b>	
PSYCHOLOGICAL MANIPULATIONS IN CYBERSPACE: MECHANISMS OF SOCIAL ENGINEERING IMPACT ON POTENTIAL VICTIMS	56
<b><u>C. Bazilo, M. Bondarenko, L. Usyk, E. Faure</u></b>	
ULTRASONIC TECHNOLOGY FOR PRODUCING FUNCTIONAL BEVERAGES TO REHABILITATE AND PREVENT POST-TRAUMATIC STRESS DISORDERS	59
<b><u>O. Shymko, V. Tuz</u></b>	
IMPROVING THE CONTROL SYSTEM OF AN UNMANNED VEHICLE	61
<b><u>V. Tupota, I. Zhaivoronok, M. Bondarenko</u></b>	
SYSTEM FOR DETERMINING THE MECHANICAL STRENGTH OF SAFETY GLASS	63
<b><u>V. Kodola, S. Saienko, M. Bondarenko</u></b>	
ANALYSIS AND MODELING OF HEAT TRANSFER PROCESSES DURING NANOMETRIC MEASUREMENTS	65
<b><u>A. Bobrov, V. Andreiko, M. Bondarenko</u></b>	
MULTIFUNCTIONAL LASER CORRECTION COMPLEX FOR OPTICAL SYSTEMS	67
<b><u>N. Bondarenko</u></b>	
DATA ANALYSIS IMPACT ON SCIENTIFIC RESEARCH	69
<b><u>O. Berezhnyi, V. Tuz, R. Trembovetska</u></b>	
DEVELOPMENT AND RESEARCH OF AN AUTOMATED SYSTEM FOR PREVENTING CRITICAL SHOCK AND WAVE LOADS	71
<b><u>V. Syvachenko, V. Tuz</u></b>	
CONTROL SYSTEM FOR A BIOREACTOR	73
<b><u>D. Holoborodko, S. Filimonov</u></b>	
DEVELOPMENT OF RADIO-CONTROLLED PIEZOELECTRIC ROBOT	75
<b><u>O. Stankevych, V. Tuz</u></b>	
AUTOMATION CONTROL OF COUNTRY HOUSE BY VOICE AI ASSISTANT	77
<b><u>I. Chornovil, V. Tuz, R. Trembovetska</u></b>	
DEVELOPMENT AND RESEARCH OF AN AUTOMATIC REAGENT DOSING SYSTEM	80
<b><u>A. Sotnyk, V. Tuz</u></b>	
MODELING OF HIGH-PERFORMANCE SONAR FOR THREE-DIMENSIONAL MAPPING OF THE RESERVOIR BOTTOM	82
<b><u>V. Starikov, V. Tuz, V. Tychkov</u></b>	
IMPROVEMENT OF THE WIND TURBINE CONTROL SYSTEM	84
<b><u>S. Matviienko, V. Tuz</u></b>	
DEVELOPMENT AND RESEARCH OF A CONTROL SYSTEM FOR A ROD SUBMERSIBLE PUMP	86

<b><u>V. Bondar</u></b>		
	<i>THE MAIN TYPES OF MODELS IN MACHINE LEARNING</i>	<b>88</b>
<b><u>I. Zdoryk, V. Tuz, R. Trembovetska</u></b>		
	<i>IMPROVEMENT OF THE CHARGING SYSTEM OF A LITHIUM-ION BATTERY</i>	<b>91</b>
<b><u>V. Kulba, V. Tuz, V. Tychkov</u></b>		
	<i>CONTROL SYSTEM FOR URBAN TRAFFIC LIGHT NETWORK</i>	<b>93</b>
<b><u>A. Romanov</u></b>		
	<i>ARTIFICIAL INTELLIGENCE APPLICATIONS IN THE ENERGY SECTOR FOR IMPROVING POWER SYSTEM MANAGEMENT</i>	<b>95</b>
<b><u>O. Brunov</u></b>		
	<i>TECHNOLOGIES OF SUPERCONDUCTIVITY AND THEIR POTENTIAL IMPACT ON THE FUTURE OF ELECTRICAL ENGINEERING</i>	<b>97</b>
<b><u>A. Toptun</u></b>		
	<i>ANALYSIS OF MATERIALS FOR THE PRODUCTION OF WIND TURBINE BLADES</i>	<b>99</b>
<b><u>M. Manko, V. Tuz</u></b>		
	<i>ANALYSIS OF TYPES AND METHODS FOR GENERATING QUANTUM SECRET KEYS</i>	<b>101</b>
<b><u>D. Polukhin</u></b>		
	<i>ANALYSIS OF AUTOMATION OF TECHNOLOGICAL PROCESSES BY ROBOTIC MANIPULATORS</i>	<b>103</b>
<b><u>O. Snisarenko, V. Tuz</u></b>		
	<i>IMPROVEMENT OF AN AUTOMATED QUALITY CONTROL SYSTEM FOR OPTICAL PARTS</i>	<b>105</b>
<b><u>B. Savosta, V. Tuz, V. Halchenko</u></b>		
	<i>MODELING AND DEVELOPMENT OF A SYSTEM FOR NON-CONTACT MEASUREMENT OF MECHANICAL CHARACTERISTICS OF THE ELECTRIC DRIVE</i>	<b>108</b>
<b><u>D. Dvoriatkin, V. Tuz</u></b>		
	<i>IMPROVEMENT OF THE THERMAL REGIME CONTROL SYSTEM IN INDUSTRIAL PREMISES</i>	<b>111</b>
<b><u>D. Moiseiev, V. Tuz, V. Halchenko</u></b>		
	<i>DEVELOPMENT AND RESEARCH OF A SYSTEM FOR CONTROLLING THE CONCENTRATION OF EXPLOSIVE DUST AND GAS COMPONENT OF THE ATMOSPHERE</i>	<b>114</b>
<b><u>N. Bugaichuk, V. Tuz, O. Kamsha, R. Trembovetska</u></b>		
	<i>DEVELOPMENT AND RESEARCH OF A MICROPROCESSOR CONTROL SYSTEM FOR AN ELECTRICAL MEASURING ROBOT</i>	<b>117</b>
<b><u>I. Tsarenko, S. Filimonov</u></b>		
	<i>IMPROVEMENT OF THE AUTOMATING SYSTEM OF THE THERMAL ENERGY PRODUCTION FACILITY</i>	<b>120</b>

UDC 621.313.13:621.317

**Bohdan Savosta**, post-graduate student at the Department of Instrumentation, Mechatronics and Computerized Technologies, Cherkasy State Technological University, e-mail: [b.b.savosta.fetam23@chdtu.edu.ua](mailto:b.b.savosta.fetam23@chdtu.edu.ua)

**Vyacheslav Tuz**, Cand.Tech.Sc., Associate Professor, Associate Professor at the Department of Instrumentation, Mechatronics and Computerized Technologies, Cherkasy State Technological University, e-mail: [v.tuz@chdtu.edu.ua](mailto:v.tuz@chdtu.edu.ua)

**Volodymyr Halchenko**, Dr.Sc., Professor, Professor at the Department of Instrumentation, Mechatronics, and Computerized Technologies, Cherkasy State Technological University, e-mail: [v.halchenko@chdtu.edu.ua](mailto:v.halchenko@chdtu.edu.ua)

## MODELING AND DEVELOPMENT OF A SYSTEM FOR NON-CONTACT MEASUREMENT OF MECHANICAL CHARACTERISTICS OF THE ELECTRIC DRIVE

**Abstract.** This study focuses on the development and simulation of a contactless sensor system for measuring mechanical parameters of electric drives. The research involves comparing various sensor designs, constructing mathematical models, and conducting simulations to evaluate the sensor's performance and its impact on the overall system. The work demonstrates that the newly developed sensor surpasses traditional methods in terms of accuracy and reliability, particularly in industrial applications requiring precise torque control.

**Key words:** electric drive, torque control, contactless sensor, magnetic-elastic sensors, mathematical modeling, ANSYS Maxwell, MATLAB Simulink.

**Introduction.** Modern industrial processes require increasingly precise control over mechanical parameters such as torque in electric drives. Traditional methods of torque measurement, such as strain gauges with contact rings or indirect methods relying on phase current and voltage measurements, have significant limitations. Contact methods are prone to wear and inaccuracies due to mechanical friction, while indirect methods may introduce measurement errors in dynamic or non-stationary conditions. Given these limitations, the development of a contactless measurement system is critical for improving accuracy and reducing the maintenance demands on electric drives in various industrial sectors.

The purpose of this study is to design and simulate a system for contactless measurement of mechanical parameters, particularly torque, in electric drives. The developed system aims to be more accurate and reliable than existing solutions. The research also investigates the impact of the sensor on the performance of the entire electric drive system and provides recommendations for its practical implementation.

The main objective is to develop a reliable and accurate contactless sensor system for measuring mechanical parameters in electric drives, with a specific focus on torque control. This involves comparing various sensor designs, conducting simulations to identify the most suitable model, and validating the sensor's effectiveness through mathematical modeling and experimental setups.

The tasks include:

A comprehensive analysis of current methods for torque measurement in electric drives.

Selection and simulation of different sensor constructions to identify the optimal design.

Development of a mathematical model to simulate the sensor's impact on the electric drive system.

Design of test benches for further experimental validation.

**Methods and Materials.** An analysis of traditional methods for measuring the mechanical parameters of electric drives was conducted, including indirect methods, strain gauges with slip rings, and photoelastic transducers. However, all these methods have several significant drawbacks:

- Indirect methods: High measurement error due to changes in motor characteristics during operation.
- Strain gauges with slip rings: Contact wear and limitations on the maximum shaft speed.
- Photoelastic transducers: Installation complexity and low accuracy.

To overcome these limitations, a contactless magnetoelastic sensor was selected.

The developed ring-shaped magnetoelastic sensor, with a doubled number of measuring poles, offers several advantages:

- High noise immunity: The doubled number of measuring coils allows the device to effectively filter external electromagnetic interference.
- Compactness: The design enables integration into systems with limited space.
- Reliability: The absence of contact elements extends the device's service life.

Magnetic field simulation results showed that the sensor design ensures uniform field distribution around the entire shaft perimeter (Fig. 1).

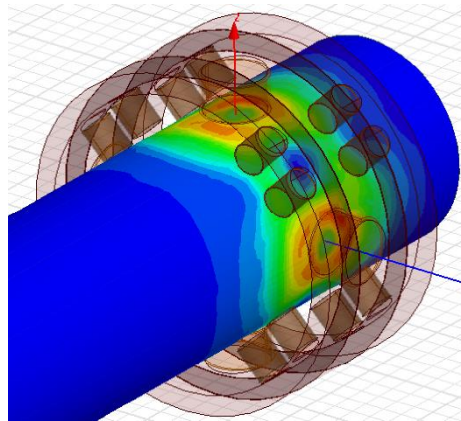


Fig. 1. Magnetic fields in the ring sensor with a doubled number of poles

An electric drive model was built in MATLAB Simulink, including two operating modes:

- Ideal mode (no sensor error considered).
- Real mode (accounting for the characteristics of the developed sensor).

A comparison of time-domain characteristics showed that peak torque deviations during sudden load changes did not exceed 2.3%, which is within the allowable error range (Fig. 2).

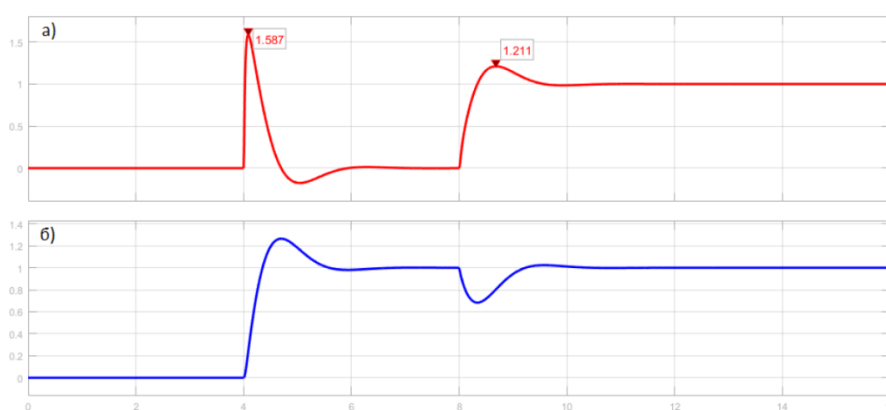


Fig. 2. Time-domain characteristics of torque and speed with the sensor

To validate the developed sensor, two types of test benches were created:

- Manual test bench: Allows basic measurements and sensor calibration.
- Automated test bench: Provides simulation of complex operating modes and recording of dynamic characteristics.

Tests on the benches demonstrated that the system operates reliably when measuring torque in the range of 500–700 Nm, ensuring high measurement accuracy and a fast response to load changes.

Special attention was given to the analysis of transient processes. The system effectively recorded torque changes with minimal delays, which is critical for applications in dynamic systems such as rolling mills and conveyor lines.

Figure 3 shows the transient processes during load changes, indicating that the torque stabilization time does not exceed 0.5 seconds.

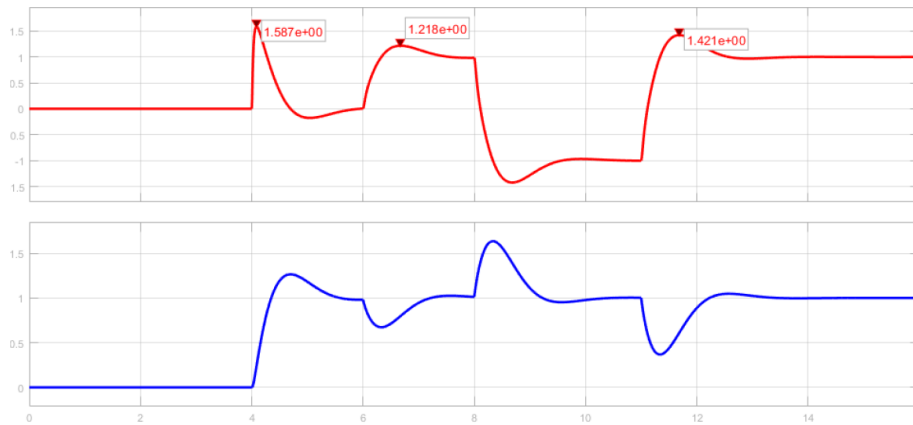


Fig. 3. Transient processes during load changes

Mathematical modeling demonstrated that incorporating the sensor into the control loop does not significantly affect the overall system dynamics. Regulation parameters remain stable, and the accuracy of maintaining the set torque improves.

**Conclusions.** The developed contactless system for measuring mechanical parameters in electric drives has demonstrated high accuracy, with a measurement error not exceeding 2.3%, and excellent sensitivity, ensuring precise torque control within the range of 500–700 N·m. The optimal sensor design was identified as a ring-shaped model with double poles, offering enhanced accuracy, reliability, and high resistance to noise.

Modeling and testing confirmed that the proposed system can be integrated into a wide range of industrial applications, including metallurgical plants, automated assembly lines, and transportation systems, without compromising the performance of electric drives. Due to its fast response time and resistance to external interference, the system is well-suited for dynamic processes that require precise parameter control.

Future work will focus on experimental validation of the sensor using the designed test benches, as well as exploring its potential applications in various industrial processes to enhance their efficiency and reliability.

---

## References

---

1. Brandl M., Haas F., Marik R. Contactless Torque Sensor. Mechatronic Principle and Prototype Development for Automotive Applications. In Proceedings of the 6th International Conference on Informatics in Control, Automation and Robotics - Intelligent Control Systems and Optimization, pages 55-61.
2. Nouman M., Khoo S. Y., Mahmud M. A. P., Kouzani A. Z. Recent Advances in Contactless Sensing Technologies for Mental Health Monitoring. IEEE Internet of Things Journal, vol. 9, no. 1, pp. 274-297, 2022.
3. Моделювання електромеханічних систем. Математичне моделювання систем асинхронного електроприводу [Modelling of electromechanical systems. Mathematical modelling of asynchronous electric drive systems]: навчальний посібник / О. І. Толочко. – Київ, НТУУ «КПІ», 2016. 150 с.
4. Системи керування електроприводами [Electric drive control systems]. Видання 2: Навч. посібник з дисципліни «Системи керування електроприводами» (для студентів спеціальності 151 «Автоматизація та комп'ютерно-інтегровані технології» денної і заочної форми навчання). Краматорськ: ДДМА, 2018. 225 с.