

**MEHAANIKATEADUSKOND
MEHHATROONIKAINSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2013**

1. Instituudi struktuur

**Mehhatroonikainstituut, Department of Mechatronics
Instituudi direktor Mart Tamre**

- Kvaliteeditehnika ja metroloogia õppetool, Chair of Quality Engineering and Metrology, Toomas Kübarsepp
- Mehhanosüsteemide komponentide õppetool, Chair of Mechanosystem Components, Trieu Minh Vu
- Mehhatroonikasüsteemide õppetool, Chair of Mechatronics Systems, Mart Tamre
- Mehhatroonika-, mehhanosüsteemide teadus- ja katselaboratoorium, Laboratory for Mechatronics, Mechano and Measurement Systems

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

Uurimisgrupid

**Metroloogia ja kvaliteeditehnika
Metrology and Quality Engineering
Prof. Toomas Kübarsepp**

The research group active in the metrology field involves three researchers (PhD) and two PhD students. Main research is connected with the investigations and developments in three directions of fundamentals of measurements: electrical conductivity, measurements of geometric and optical quantities. These three directions are tightly connected from the point of measurements and measurement technique and one of the goals is focusing on the theoretical basis of the coherency of those fields. Improved measurement methods (electrical conductivity measurements with planar coils) and unique design high-level measurement equipment (photodetectors for precise measurements of low photon flows – single to some thousand photons). The research group was financed from the TUT R&D project „Metrology in today’s sciences“. There is an active collaboration with other EU universities and research institutions. A good example of this kind of collaboration is work at the EU Metrology programme EMRP project NEWSTAR - New Primary Standards and Traceability for Radiometry (http://www.euramet.org/fileadmin/docs/EMRP/JRP/JRP_Summaries_2012/SI_Broader_Scope_JRPs/SIB57_Publishable_JRP_Summary.pdf)

Publications

1. Pokatilov, A.; Parker, M.; Kolyshkin, A.; Märten, O.; Kübarsepp, T. (2013). Inhomogeneity Correction in Calibration of Electrical Conductivity Standards. *Measurement*, 45, 1535 - 1540.
2. Parker, M.; Pokatilov, A.; Kübarsepp, T.; Märten, O.; Kolyshkin, A. (2013). Investigation of planar coil for eddy current conductivity measurements in wide frequency range. In:

- Instrumentation Viewpoint: 19th Symposium IMEKO TC 4 Symposium and 17th IWADC Workshop Advances in Instrumentation and Sensors Interoperability July 18-19, 2013, Barcelona, Spain. (Toim.) Antoni Manuel Lazaro., 2013, 55 - 59.
3. Vabson, V.; Vendt, R.; Kübarsepp, T.; Noorma, M. (2013). Method for revealing biases in precision mass measurements. *Measurement Science & Technology*, 24(2), 025004.
 4. M. Sildoja, F. Manoocheri, M. Merimaa, E. Ikonen, I. Müller, L. Werner, J. Gran, T. Kübarsepp, M. Smîd and M. L. Rastello (2013). Predictable Quantum Efficient Detector I: Photodiodes and Predicted Responsivity. *Metrologia*, 385.
 5. I. Müller, U. Johannsen, U. Linke, L. Socaciu-Siebert, M. Smîd, G. Porrovecchio, M. Sildoja, F. Manoocheri, E. Ikonen, J. Gran, T. Kübarsepp, G. Brida, and L. Werner (2013). Predictable Quantum Efficient Detector II: Characterisation and Confirmed Responsivity. *Metrologia*, 395.

Mehhanosüsteemide modelleerimine

Mechanosystem modeling

Prof. Trieu Minh Vu

The focus in the research is on multibody system dynamics, vibration analysis and monitoring targeted on modelling, and optimization of systems and materials behavioural characteristics and essentially the research is focused on the performance of teleoperated robots, which depends on the remote human awareness and the remote robot manipulation ability. In real operations, the operator performance is also degraded because of the robotic manipulation failures or instability. In this case, the development of intelligent sensors and actuators are important to enhance the remote awareness for the operators. The new systems help to interpret the sensing data, to improve the judgments about the remote environments.

Innovative technologies have been investigated to enhance the operator performance and improve the potential degradations discussed above. The new display designs and the human performance issues include stereoscopic displays, multimodal interfaces and predictive displays: Stereoscopic displays allow faster and more accurate perception of the remote scene, enhancing the object recognition for the operators. Multimodal interfaces provide multiple human sensory channels and enhance the operator performance. Finally, predictive displays used the computer to predict the future data can eliminate the time-delay effects from the communication.

Publications

1. Vu, Trieu Minh (2013). Fuzzy logic and slip controller of clutch and vibration for hybrid vehicle. *International Journal of Control, Automation and Systems*, 11, 526 - 532.
2. Vu, Trieu Minh (2013). Stability for switched dynamic hybrid system. *Mathematical and Computer Modelling*, 57, 78 - 83.
3. Vu, Trieu Minh (2013). *Trajectory Generation for Autonomous Vehicles*. Not (615 - 626).Springer
4. Vu, Trieu Minh (2013). Development and Simulation of an Adaptive Control System for the Teleoperation of Medical Robots. Maki K. Habib and J. Paulo Davim (Toim.). Not (173 - 185).IGI Publishing
5. Aryassov, Gennadi; Zhigailov, Sergei (2013). Optimal Design of System of Cross-Beams. *Solid State Phenomena*, 675 - 680.

Mehhatroonikasüsteemid

Mechatronics Systems

Prof. Mart Tamre

The research is focused on proactive smart machine and robotic and production systems, models and optimization for production and service system automation. Activity of is concentrated on two main subfields: Proactive decision support in networked collaborating enterprises of special tooling and machining clusters and modeling and design of proactive autonomous service and technology components. Intelligent prediction of manufacturing capability in enterprises cluster for preventing management failures enables achieving of near-zero downtime and the best possible quality of a product. Proactive hardware components will be able to react autonomously and flexibly to changing environments and configuration of the networked system structure according to the software control whereby service and industrial system components especially industrial or service robots and their component design are under investigation. Intelligent prediction of manufacturing capability in enterprises cluster for preventing management failures has been tested utilizing smart grid technology and several production models that enable achieving of greater efficiency. Proactive system behavior have been investigated on the example of the whole production chain of wood product chain where the energy consumption in wide sense and environment impact is used as driving parameters in a technology process. This kind of tests were performed for whole wood production chain where a subtask was automatic building a sensor network in very beginning of operating materials for production of the artificial objects up to sensor systems at the end production, considering time and space separation and distribution of the information and decision/control processes. In parallel reconfigurable robot control, algorithms have been investigated in case of modifying sensor network and multy-robot collaboration (UGV and UAV case) where the control optimization and mission planning from the safety critical and energy consumption viewpoint is of interest.

Publications

1. Hudjakov, Robert; Tamre, Mart (2013). Orthophoto Classification for UGV Path Planning using Heterogeneous Computing. *International Journal of Advanced Robotic Systems* , 10, 1 - 7.
2. Tiimus, Kristjan; Tamre, Mart (2013). MODULAR MULTI-ROTOR HELICOPTER PLATFORMS. In: *Proceedings of the 9th International Conference Mechatronics Systems and Materials MSM2013: 19th Conference Mechatronic Systems and Materials 2013, MSM'2013 Vilnius , Lithuania, July 01-03, 2013.* (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: Vilnius Gediminas Technical University Press "Technika", 2013.
3. Tiimus, Kristjan; Murumäe, Mikk; Väljaots, Eero; Tamre, Mart (2013). High-efficiency internal combustion engine for unmanned aircraft use. In: *Proceedings of 9th International Conference: Mechatronic Systems and Materials - MSM-2013: The 9th International Conference: Mechatronic Systems and Materials - MSM-2013, Vilnius, Lithuania, 1 - 3 July 2013.* (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: Vilnius Gediminas Technical University Press "Technika", 2013.
4. Sell, Raivo; Petritsenko, Andres (2013). Early design and simulation toolkit for mobile robot platforms. *International Journal of Product Development*, 18, 168 - 192.

5. Shvarts, Dmitry; Tamre, Mart (2013). Global 3D Map Merging Methods for Robot Navigation., Tallinna Tehnikaülikool) Tallinn: TTU Press

2.2 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed.

- Prof. M.Tamre
 - IEEE
 - ASME
 - Robotics Industries Association (RIA)
 - AUVSI
- Prof. T.M.Vu - Membership of Professional Societies:
 - Member of Institute of Electrical and Electronics Engineering – Control System Society (IEEE-CSS).
 - Member of Asian Control Association (ACA).
 - Member of review Committee of Asian Journal of Control (AJC).
 - Member of review Committee of International Symposium on Neutral Networks (ISNN).
- Dots. G.Arjassov
 - Sankt- Peterburi Teaduste Maja ehitusmehaanika ja tugevusõpetuse teadusseltsi auliige ning toimetuskolleegiumi liigerahvusvaheliste konverentside orgkomitee liige.
- Tiia Tammaru
 - Eesti Juhtimiskvaliteediauhind 2010, zürri esimees
 - Eesti Kvaliteediühing, juhatuse esimees
 - EVS tehniline komitee 33 'Juhtimissüsteemid', liige
 - European Organization for Quality (EOQ), asepresident
 - Eesti Kutseõppeasutuste Kvaliteediauhind, ekspert
 - Eesti Juhtimiskvaliteedi Auhind Ekspertühma liige / juhtiv ekspert
 - European Organization for Quality (EOQ) Juhatuse liige
 - Eesti Kvaliteediühing Juhatuse liige
- Prof. Toomas Kübarsepp
 - Eesti Standardikeskuse Nanotehnoloogia tehnilise komitee asutajaliige
 - Euroopa regionaalse metroloogiaorganisatsiooni EUROMET Eesti Vabariigi delegaat
 - Metroloogianõukogu liige (EV Majandus- ja Kommunikatsiooni-ministeerium)

2.3 Hinnang mehhatroonikainstituudi tegevusele aruandeaastal

Publikatsioonide, patenditaotluste ja doktoritööde osas oli aruandeaasta mehhatroonikainstituudile edukam, võrreldes möödunud aastaga. Instituudi tegevusele jättis tugeva pitseri V korpuse remont ja sunnitud tegevus väga ajutistes ja kokkusurutud ruumides pead-jalad koos, kus laboriruumi teadustöökä äärmuseni nappis. Positiivsena võib välja tuua senisest enamat instituudi tegevuste konsolideerumist mehhatroonika, kui interdistsiplinaarse valdkonna suunale, mis küll on tähendanud senisest enamat lahknemist mehaanikateaduskonna üldisest masinaehituse ja materjalitehnika suunast.

PUBLIKATSIOONID 2013

1.1. Ajakirjaartikkel

- Vendt, R., Vabson, V., Kübarsepp, T., Noorma, M. (2013). Traceability of temperature measurements in Estonia. Proceedings of the Estonian Academy of Sciences, 116 – 121
- Randrüüt, Merle; Braun, Manfred (2013). Cnoidal waves governed by the Kudryashov-Sinelshchikov equation. Physics Letters A, 377(31-33), 1868 - 1874
- Sell, Raivo; Petritsenko, Andres (2013). Early design and simulation toolkit for mobile robot platforms. International Journal of Product Development, 18, 168 – 192
- Vu, Trieu Minh (2013). Fuzzy logic and slip controller of clutch and vibration for hybrid vehicle. International Journal of Control, Automation and Systems, 11, 526 - 532.
- Pokatilov, A.; Parker, M.; Kolyshkin, A.; Märtens, O.; Kübarsepp, T. (2013). Inhomogeneity Correction in Calibration of Electrical Conductivity Standards. Measurement, 45, 1535 - 1540.
- Aryassov, Gennadi; Zhigailov, Sergei (2013). Optimal Design of System of Cross-Beams. Solid State Phenomena, 675 - 680.
- Aleksandrov, D.; Penkov, I. (2013). Optimization of Lift Force of Mini Quadrotor Helicopter by Changing of Gap Size Between Rotors. Solid State Phenomena, 226 - 231.
- Hudjakov, Robert; Tamre, Mart (2013). Orthophoto Classification for UGV Path Planning using Heterogeneous Computing. International Journal of Advanced Robotic Systems, 10, 1 - 7.
- Sildoja, Meelis et al (2013). Predictable Quantum Efficient Detector I: Photodiodes and Predicted Responsivity. Metrologia, 385
- Müller, Ingmar et al (2013). Predictable Quantum Efficient Detector II: Characterisation and Confirmed Responsivity. Metrologia, 395
- Vu, Trieu Minh (2013). Stability for switched dynamic hybrid system. Mathematical and Computer Modelling, 57, 78 - 83.

2.2. Kogumiku artikkel

- Vu, Trieu Minh (2013). Development and Simulation of an Adaptive Control System for the Teleoperation of Medical Robots. Maki K. Habib and J. Paulo Davim (Toim.). Not (173 - 185).IGI Publishing
- Vu, Trieu Minh (2013). Trajectory Generation for Autonomous Vehicles. Not (615 - 626).Springer

2.3. Dissertatsioon

- Shvarts, Dmitry; Tamre, Mart (2013). 3D globaalkaardi ühendamise meetodid roboti navigeerimiseks., Tallinna Tehnikaülikool) Tallinn: TTU Press
- Vendt, Riho (2013). Combined method for establishment and dissemination of the international temperature scale.University of Tartu Press
- Aleksandrov, Dmitri (2013). Light-Weight Multicopter Structural Design for Energy Saving. (Doktoritöö, Tallinna Tehnikaülikool) Tallinn: Tallinn University of Technology Press
- Hiiemaa, Maido (2013). Motion Planner for Skid-Steer Unmanned Ground Vehicle., Tallinna Tehnikaülikool) Tallinn: Tallinn University of Technology Press

3.1. Kogumiku artikkel

- Seiler, Sven; Sell, Raivo (2013). Comprehensive blended learning concept for teaching micro controller technology utilising HomeLab kits and remote labs in a virtual web environment. Pan, Z.; Cheok, A.D.; Müller, W.; Iurgel, I.; Petta, P.; Urban, B. (Toim.). Transactions on Edutainment X (161 - 177). Berlin-Heidelberg: Springer

Aryassov, Gennady; Barashkova, Tatjana; Gornostajev, Dmitry (2013). Estimation of the Improved Method of Grids and Application for Dynamic Solution. B. Katalinic (Toim.). DAAAM INTERNATIONAL SCIENTIFIC BOOK (571 - 586). DAAAM International Vienna, TU Wien, Karlsplatz 13/311, A-1040 Vienna, Austria : DAAAM International Vienna

Surzhenkov, A.; Adoberg, E.; Pödra, P.; Sergejev, F.; Mere, A.; Viljus, M.; Mikli, V.; Antonov, M.; Kulu, P. (2013). Impact and Sliding Wear Properties of Single Layer, Multilayer and Nanocomposite Physical Vapour Deposited (PVD) Coatings on the Plasma Nitrided Low-Alloy 42CrMo4 Steel. Hussainova, I. (Toim.). Engineering Materials and Tribology (223 - 228). Trans Tech Publications Ltd

3.1. Publitseeritud konverentsiettekanded

Eduardo Corral, Gennady Aryassov, Jesus Meneses (2013). A QUASI-STATIC APPROACH TO OPTIMIZE THE MOTION OF AN UGV DEPENDING ON THE TRACK PROFILE. In: Proceedings of the 9-th International Conference Mechatronics Systems and Materials MSM2013: 9th Conference Mechatronic Systems and Materials 2013, MSM'2013 Vilnius , Lithuania, July 01-03, 2013. (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: Vilnius Gediminas Technical University Press "Technika", 2013, 41 - 42.

Dmitri Gornostajev, Gennady Aryassov, Sergei Zhigailov (2013). DEVELOPMENT OF THE CALCULATION METHOD OF PLATES FOR OPTIMIZATION OF BARGE HULL THICKNESS . In: Proceedings of the 9th International Conference Mechatronics Systems and Materials MSM 2013: 9th Conference Mechatronic Systems and Materials 2013, MSM'2013 Vilnius , Lithuania, July 01-03, 2013. (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: Vilnius Gediminas Technical University Press "Technika", 2013, 77 - 78.

Pokatilov, A.; Parker, M.; Kübarsepp, T.; Märten, O.; Kolyshkin, A. (2013). Grid-based computational algorithm for accurate AC conductivity measurements. 16th International Congress of Metrology, Paris, France, October 7-10, 2013. EDP Sciences, 201

Tiimus, Kristjan; Murumäe, Mikk; Väljaots, Eero; Tamre, Mart (2013). High-efficiency internal combustion engine for unmanned aircraft use. In: Proceedings of 9th International Conference: Mechatronic Systems and Materials - MSM-2013: The 9th International Conference: Mechatronic Systems and Materials - MSM-2013, Vilnius, Lithuania, 1 - 3 July 2013. (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: Vilnius Gediminas Technical University Press "Technika", 2013.

Parker, M.; Pokatilov, A.; Kübarsepp, T.; Märten, O.; Kolyshkin, A. (2013). Investigation of planar coil for eddy current conductivity measurements in wide frequency range. In: Instrumentation Viewpoint: 19th Symposium IMEKO TC 4 Symposium and 17th IWADC Workshop Advances in Instrumentation and Sensors Interoperability July 18-19, 2013, Barcelona, Spain. (Toim.) Antoni Manuel Lazaro., 2013, 55 - 59.

Zhigailov, Sergei; Kuznetsov, Artem; Musalimov, Victor; Aryassov, Gennady (2013). MEASUREMENT AND ANALYSIS OF HUMAN LOWER LIMBS MOVEMENT PARAMETERS DURING WALKING. In: Proceedings of the 9th International Conference Mechatronics Systems and Materials MSM-2013: 9th Conference Mechatronic Systems and Materials 2013, MSM'2013 Vilnius , Lithuania, July 1-3, 2013. (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: VGTU Press "Technika", 2013, 268.

Tiimus, Kristjan; Tamre, Mart (2013). MODULAR MULTI-ROTOR HELICOPTER PLATFORMS. In: Proceedings of the 9th International Conference Mechatronics Systems and Materials MSM2013: 19th Conference Mechatronic Systems and Materials 2013, MSM'2013 Vilnius , Lithuania, July 01-03, 2013. (Toim.) Olegas Cernasejus and Arturas Kilikevicius. Vilnius, Lithuania: Vilnius Gediminas Technical University Press "Technika", 2013.

Väljaots, Eero; Sell, Raivo; Kaeeli, Mati (2013). Motion and Energy Efficiency Parameters of Unmanned Ground Vehicle. In: Proceedings of 9th International Conference: Mechatronic Systems and Materials - MSM-2013: The 9th International Conference: Mechatronic Systems and

Materials - MSM-2013, Vilnius, Lithuania, 1 - 3 July 2013. Vilnius: Vilnius Gediminas Technical University Press "Technika", 2013.

3.2. Publitseeritud konverentsiettekanded

Aryassov, G.; Zhigailov, S. (2013). Approximation of Limit Amplitudes of Stresses. In: Topical Problems in the Field of Electrical and Power Engineering: 13th International Symposium "Topical Problems in the Field of Electrical and Power Engineering* Doctoral School of Energy and Geotechnology", Pärnu, Estonia, 14-19 January, 2013. (Toim.) Janis Zakis. Tallinn University of Technology, Elektriiaam, 2013, 332 - 333.

Kuznetsov, A.; Zhigailov, S. (2013). Design of Orthesys for Correction of Human Gait. In: Proc. of 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering, Estonia, Pärnu, 2013. (Toim.) Zakis, J.. Tallinn: Elektriiaam, 2013, 289 - 291.

Katušin, Dmitri; Vu, Trieu Minh; Antonov, Maksim; Yung, Der-Liang (2013). Laboratory Testing of Materials for Tunnel Boring Machine Drag Bits. In: Proc. of 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering, Estonia, Pärnu, 2013. (Toim.) Zakis, J.. Tallinn: Elektriiaam, 2013, 300 - 303.

Sell, Raivo; Seiler, Sven (2013). Learning Situations and Remote Labs in Embedded System Education. In: Proceedings of 14th International Workshop on Research and Education in Mechatronics: 14th International Workshop on Research and Education in Mechatronics. (Toim.) Viktorio Malisa & Titanilla Komenda. Vienna, Austria: Association for Supporting Automation and Robotics, 2013, 97 - 101.

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Aleksandrov, Dmitri; Penkov, Igor (2013). Rotor Lifting Force Optimization by Changing Dimensions of Rim Around it. In: 13th International Symposium TOPICAL PROBLEMS IN THE FIELD OF ELECTRICAL AND POWER ENGINEERING: Doctoral School of Energy and Geotechnology II, PÄRNU 2013. Elektriiaam, 2013, 292 - 295.

Aryassov, G.; Gornostajev, D. (2013). The Calculation of Round Plates under the Action of Local Loading by Generalized Functions. In: Topical Problems in the Field of Electrical and Power Engineering: 13th International Symposium "Topical Problems in the Field of Electrical and Power Engineering* Doctoral School of Energy and Geotechnology", Pärnu, Estonia, 14-19 January, 2013. (Toim.) Janis Zakis. Tallinn University of Technology, Elektriiaam, 2013, 296 - 299.

Põlder, Ahti; Juurma, Märt; Tamre, Mart (2013). Waste Paper Sorting Using Imaging Spectroscopy. In: Proc. of 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering, Estonia, Pärnu, 2013. (Toim.) Zakis, J.. Tallinn: Elektriiaam, 2013, 283 - 284.

Vu, Trieu Minh (2013). Vehicle Sideslip Modeling and Estimation. In: Proc. of 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 13th International Symposium, Topical Problems in the Field of Electrical and Power Engineering, Estonia, Pärnu, 2013. (Toim.) Zakis, J.. Tallinn: Elektriiaam, 2013, 37 - 41.

3.2. Ajakirja artiklid

Dhoska, Klodian; Kübarsepp, Toomas. (2013). Metrological Problem Mapping for Coordinate Measuring Machines. 13th International Symposium "TOPICAL PROBLEMS IN THE FIELD OF ELECTRICAL AND POWER ENGINEERING" and, 312 - 316.

4.2. Raamat/monograafia

Kremer, M.; Seiler, S.; Kuvaja, M.; Ptasik, D.; Lehtla, T.; Ellermaa, R.; Pähnapuu, L.; Randmaa, T.; Pikner, H.; Heinaste, U.; Bernhard, D.; Sell, R. (2013). Õpituatsioonid mehhatroonikas ja robotikas . Tallinn: Robolabor.ee kirjastus (ITT Group)

6.3. Ajakirja artiklid

Laaneots, R. (2013). Mõõteviga ja määramatus. Inseneeria, 7 - 8. [ilmumas]

Laaneots, R. (2013). Suurused, nende tähised ja väärtused. Inseneeria, 10 - 11. [ilmumas]

6.7. Kogumiku artikkel

Laaneots, Rein (2013). Ainulaadselt metroloogiast. Tallinna Tehnikaülikooli aastaraamat 2012, XX (284 - 285). Tallinn: Tallinna Tehnikaülikooli Kirjastus