INFOTEHNOLOOGIA TEADUSKONNA AUTOMAATIKAINSTITUUDI TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2011

1. Instituudi struktuur

Instituudi direktor Boris Gordon

- Automaatjuhtimise ja süsteemianalüüsi õppetool, Chair of Automatic Control and Systems Analysis, Ennu Rüstern
- Reaalajasüsteemide õppetool, Chair of Real Time Systems, Leo Mõtus
- Siduteooria ja –disaini õppetool, Chair of Circuit Theory and Design, Vello Kukk
- Proaktiivtehnoloogiate teaduslaboratoorium, Laboratory for Proactive Technologies, Jürgo-Sören Preden

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

Automaatikainstituudi teadus- ja arendustegevus on viidud proaktiivtehnoloogiate teadus-laboratooriumi alla. Teaduslaboratoorium koondab instituudi teadureid, insenere ja doktorante, kes on seotud sihtfinantseeritava teadusteemaga, ETF grantide põhitäitjaid ja muude uurimisprojektide põhitäitjaid. Teadustööga tegelevad õppejõud teevad koostööd (nt ühised publikatsioonid) labori teadustöötajatega ning on seotud sihtfinantseeritava teadusteemaga (kuuluvad põhitäitjate nimekirja).

2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide

2.1.1 teadustöö kirjeldus *(inglise keeles*);

• *Laboratory for Proactive Technologies*

• *Chair of Real Time Systems*

SF0140113As08 Proactivity and situation-awareness

Three simultaneously on-going and interacting threads are studied - proactive modelling, technology platforms and tools, and pilot applications and assessment methods. The emergent behaviour in proactive systems and their relationship to complex systems theory are of special interest. Research in proactive modelling focuses on models of situation-aware interactive computing, emergent behaviour in enterprises and organisations, self-learning and adaptation methods in control systems, and nano-components. Research on technology and tools covers agent-based and smart dust technologies, plus tools and methods for interface technologies for exchanging situational information. Pilot applications and study of methods for their assessment are divided into three parts - cases applying MATLAB/Simulink models, cases applying real world environment and physical devices, and preparatory work on set-up of verification studies.

GART5 Self-organizing middleware platform for ad-hoc networks in the domain of manufacturing and logistics

Development of a self-organizing middleware platform for ad-hoc networks in the domain of manufacturing and logistics.

ETF7693 Modelling of time-sensitive processes and emergent behaviour in multi-functional and virtual organisations

The current research project focuses on the modelling and analysis of emergent time-sensitive processes and emergent behaviour in multi-functional human organisations and enterprises. The main objective of the research is to investigate, evaluate and devise possible suitable methods for analysis and specification of modelling of time-sensitive process and emergent behaviour. The research project consists of integration of four main directions:

1. Modelling of time-sensitive emergent behaviour in organisations that operate in dynamic environment. The research concentrates on detailed development of the suitable methodology and on implementation possibilities of the methodology. There are analysed concrete applications for time-critical organisations as well as further development of a suitable modelling methodology.
2. Analysis and devising of suitable modelling approaches for life-cycle modelling and team composition in virtual enterprises and virtual organisations in general. This research co-operates with the first direction of the research with stressing virtual enterprise approach.
3. Determination of risks, necessary resources and overall volume of large software development projects. The research investigates whether an approach, similar to the one used in previous directions, can be used for such research. The aim of the research is to support analysis of necessary processes in time-sensitive organisations and in this way to prognosticate time and resources necessary for development of suitable information systems for such organisations.
4. All previous research directions should be co-ordinated and supported by a common strong theoretical approach in real-time and agent domain. To achieve the objective, interaction-based specification and modelling methods are investigated. The research combines results of recent researces in the area of stream processing, state transition machnies, persistent Turing Machines, UML and multi-agent approach and, where appropriate, also the Q-model approach.

• *Chair of Automatic Control and Systems Analysis*

ETF8738 Artificial intelligence methods based analysis and control of complex nonlinear systems

The aim of the project is to develop a control strategy combining advantages of classical analytical and different artificial intelligence based methods. The designed system should be capable of automatic control of complex multidimensional and hardly analyzable systems.

An intelligent control system should be able not only to make decisions according to a predefined algorithm or/and scenario but also to adapt to changing environment. The adaptive system has

• to be able to react to changes in its environment. It means be reactive;
• to analyze and predict the behavior of its environment. It means be proactive;
• to adjust itself and change its own behavior in response to disturbances and changes in environmental conditions.

Modern time complex intelligent control system consists of two main parts: adaptive control algorithm plus situation awareness.
There exist a number of classical control techniques the robustness and high reliability of which is proven by decades. Nevertheless, nowadays in more and more applications we need to control complex systems and processes which cannot (or it is not a trivial task) be represented by classical models. In these applications we need algorithms combining advantages of classical and artificial intelligence based methods.
During the last ten years has significantly grown the demand for automatic systems and devices in live-critical applications. This dramatically increases the requirements imposed to the quality of the control system. It means that more and more advanced control systems, precise and as simple as possible control task oriented models of very complex multidimensional and highly nonlinear systems are required.

In the framework of this project research is conducted in two directions, which are connected to each other:
1. reliable and satisfying high quality demands control algorithms for complex nonlinear multidimensional systems;
2. artificial intelligence based methods for precise recognition of environmental situation by real-time analysis of observed image, video and numerical data.

• *Chair of Circuit Theory and Design*

Project EITSA10 Development of competence-based learning environment and renewing its laboratory equipment
The goal of the project is developing new components and laboratory equipment for competence-based learning process. In 2011, further development of competence-driven learning environmnet was going on. As previous experience has shown, the crucial moment is selcting material (problems) that are given to a learner at specific time moment. This decision must be based on curent state of learner estmated by previous results processed by forgetting model. As the tasks available have multiple competence connections it is impotant to organize competences in a way that enables effective task selection both in case of automatic and manual selection. Anyway, at least one more layer is needed to organize automayic selection and second.level components must contain overlapping low-levwl comptetence sets. This model (first version) was implemented and tested in real learning process. The results demonstrated that the model is appropriate in general but more work is to be done on low level - creating more and better tasks.
Another part of wok was dvelopment of new source.scopes and variable DUTs for labs. There were two reasons for that project:
1) purely USB.based source.scope appeared to be too dependent on cahnging in system software, computers, and operating systems; new design employs audio processing facilkities which are less dependent on mentioned above aspects; new sources have replaced the old ones in homelabkits ;
2) devlopment of variable-content DUT that is device content of which can be controlled over USB; importance of that solution is remarjble increasing of different versions of devises and

their parameters; also the solution has a general part that can be used for other implementations -e.g. now using for microcontroller labs is under consideration

2.1.2 aruandeaastal saadud tähtsamad teadustulemused *(inglise keeles).*

• *Laboratory for Proactive Technologies*
• *Chair of Real Time Systems*

SF0140113As08 Proactivity and situation-awareness
The problem of studying proactivity and situation-awareness has been reformulated in 2011 (L. Motus) as elaboration of the key enabling technology for operating cognitive artificial systems. The new context fosters fusion of research made on cognitive behaviour of biological communities with the attempts of understanding and building cognitive artificial systems. For instance, research and experiments with developing individual situation-awareness, team situation-awareness (J. Preden), student's learning (M. Jaanus), adaptive entities (T. Lints), virtual organisations (T. Kangilaski), applications of artificial neural nets (I. Astrov and E. Petlenkov).
The focus of the research has been on theoretical and experimental study of situational data acquisition from heterogeneous sources, validation of the acquired data with respect to temporal and special constraints, fusion of validated information to form a hierarchy of situations and harmonisation and dissemination of situation estimates obtained from heterogeneous sources. In conjunction with situation-awareness have been studied on-line verification methods of dynamic behaviour, and for early detection of emergent behaviour. Obtained theoretical knowledge has been applied in ARTEMIS JU , NATO RTO, EDA and IMECC projects and task groups. M. Jaanus received PhD degree, and 25 papers were published, and one patent registered.

GART5 Self-organizing middleware platform for ad-hoc networks in the domain of manufacturing and logistics
Within the scope of the Simple project the project team from the Research Laboratory for Proactive Technologies was active in defining the features of the main focus of the project – the middleware. The proposed proactive middleware follows a service-based data subscriber-consumer model with constraint specifications and evaluations and it was selected as the middleware foundation for the project. The developed data exchange model allows for on-line data validation at system runtime by individual system components based on the data specified constraints. The proactive communication model for information exchange in a distributed system was developed. The proactive communication model caters for the data requirements of the data consumers, the objective being to provide the information required for forming good situational awareness of the data consumer. The proactive communication model relies on a middleware that is able to acquire the information required by the consumer and to cater for the restrictions set by the data consumer on the requested data.
The ProLab team also defined the features of the data cashing functionality of the middleware. Data caching is offered as a service by the system devices. The data caching solution for Simple allows to define the types of data that must be cached by the middleware and the constraint on the cached data. Any node in the system may participate in data caching. If the

caching service functionality is requested from a device the device starts caching the data specified in the request. The data is cached together with the metadata on the data.
The ProLab team also defined the features of the service directory functionality of the middleware. The different services offered by devices that make up the Simple system are listed in the service directory. The service directory is also a service that is offered by a device in the network. The device offering the service directory service is located by sending a query via broadcast to the network. Any device that joins the network and is capable of offering any services locates the service directory service and provides information on the services that the device is able to offer to the service directory service.
The ProLab project team participated actively in middleware definition and design efforts, including teleconferences and face-to-face meetings.
In addition to the middleware design the ProLab team was also involved in system component development, including sensor drivers, software modules for signal processing and interface components.

ETF7693 Modelling of time-sensitive processes and emergent behaviour in multi-functional and virtual organisations

In 2011 research activities concentrated on further development and implementation of the methodology for modelling time-aware processes and emergent behaviour of organisations (TEBA). The focus was on virtual organisations / virtual enterprises in production domain and in public security domain.
In cooperation with the Department of Machinery of Faculty of Mechanical Engineering were studied Enterprise Architecture frameworks and Knowledge Management techniques for re-use of manufacturing process instructions. A specific solution was elaborated for storing and representation of operational production knowledge for better organisational performance, process re-engineering and co-operation.
Based on TEBA and Enterprise Architecture Modelling approach, a change management reference model in virtual enterprises (VE) was suggested that enables integration of modelling time-aware processes with change management of goals, processes and information management.
There was also analysed how maturity models that characterise focal player of a virtual organisation (VO) can be used to analyse and estimate co-operation possibilities in a VO as the whole.
Also there has been researched how to combine modelling of time-sensitive tactical-level processes in an organisation with the planning activities on strategic, operation and tactical levels. The research was currently focussed on public security domain as the processes there are time-sensitive and resources are concurrently used for multiple tasks. The TEBA methodology was enhanced for implementation in that domain. As a result, a combined reference model that integrates modelling of time-aware processes on tactical level with strategic and operative planning activities was composed.
Supervision of Maarja Vesi's Master Thesis "Methodology for evaluating the impact of ICT interruptions on the example of the Police and Border Guard Board" (in Estonian, original title "Info- ja kommunikatsioonitehnoloogia katkestuste mõju hindamise metoodika Politsei- ja Piirivalveameti näitel") was successful. The Thesis was defended on 20 May 2011 in the Estonian Academy of Security Sciences.

There have been published 3 articles in 2011 and participated in some conferences and seminars. In addition, there is published 1 popular science article in a journal. Based on results achieved in 2011, one article is published in 2012.

• *Chair of Automatic Control and Systems Analysis*

ETF8738 Artificial intelligence methods based analysis and control of complex nonlinear systems

A dynamic pole placement algorithm based on feedback linearization of a nonlinear system where poles of the closed loop system can be moved according to fuzzy rules is designed. The proposed algorithm provides significant improvement in characteristics of the transient process.

The stability of closed loop systems with feedback linearization is studied and a theorem for determining the region of admissible values is proved.

The problem of model structure selection is especially important in case of NN-based models because of risk of overparameterization. A method for identification of a minimal or reduced NN-based model of a nonlinear system is developed. GA is applied to structural identification of NN- ANARX model providing an optimal structure of the model from the control point of view.

A system capable of distinguishing between several different internal organs and analyzing consecutive images received from the endoscope during abdominal surgery in real time is designed and implemented in software.

A MATLAB Toolbox for fractional order control of complex systems is designed and will be developed in the next years.

All the above mentioned results are presented in 7 publications.

• *Chair of Circuit Theory and Design*

Project EITSA10 Development of competence-based learning environment and renewing its laboratory equipment

1. New post-processing algorithms for multistep solutions that enable to avoid interruption of analysis when errors appear at early steps of solution proposed by a student. Those algorithms make possible extraction of competence-related infomation from full solution.
2. New double-level task models that made possible new control algorithms for task selection on the base of current state of student’s knowledge and higher-level graphical representation.
3. New source-scope instruments using audio processing capabilities of computers which are more reliable and almost indpendent upon changes in operating systems.
4. Development of variable-content DUT (device-under-test) which can be operated over USB connection and extending the range of parameters devices used in labs.

2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

• *Proaktiivtehnoloogiate teaduslaboratoorium*

SF0140113As08

Riid, A.; Rüstern, E. (2011) Identification of transparent, compact, accurate and reliable linguistic fuzzy models, Information Sciences, 183(20), 4378 – 4393

Preden, J.; Motus, L.; Meriste, M.; Riid, A. (2011) Situation Awareness for Networked Systems, IEEE International Multidisciplinary Conference on Cognitive Methods in Situation Awareness and Desicion Support - IEEE COGSIMA 2011, Miami, USA, Feb. 22-24,2011. , 2011.

Rannat, K.; Meriste, M.; Helekivi, J.; Kelder, T. (2011) Models of Indoor Environments –a Generic Interactive Model for Design and Simulation of Building Automation, Bhatt, M.; Guesgen, H. (Toim.). Situational Awareness for Assistive Technologies (40 - 60).IOS Press [ilmumas]

Astrov, I. ; Pedai, A. (2011). Situational awareness based flight control of a drone. In: SysCon 2011 Proceedings: 2011 IEEE International Systems Conference (SysCon 2011, Montreal, Quebec, Canada, April 4-7, 2011). IEEE, 2011, 574 - 578.

Vassiljeva, K; Belikov, J; Petlenkov, E. (2011) Neural networks based minimal or reduced model representation for control of nonlinear MIMO systems. In: The 2011 International Joint Conference on Neural Networks, IJCNN 2011 Conference Proceedings: San Jose, California, USA, July 31 - August 5, 2011: Piscataway, NJ: IEEE, 2011, 1706 - 1713.

GART5

Preden, J.; Motus, L.; Meriste, M.; Riid, A. (2011). Situation Awareness for Networked Systems. IEEE International Multidisciplinary Conference on Cognitive Methods in Situation Awareness and Desicion Support - IEEE COGSIMA 2011, Miami, USA, Feb. 22-24,2011. , 2011.

ETF7693

Savimaa, R.; Tenno, A.; Moora, P. (2011). Modelling of processes and emergent behaviour in public security domain (in Estonian, original title: Protsesside ja ilmneva käitumise modelleerimine siseturvalisuse valdkonnas). Proceedings of Academy of Security Sciences, 10, 40 - 65.

Savimaa, R.; Kangilaski, T.; Polyantchikov, I. (2011). A framework for time-aware change management in virtual enterprises. Branko Katalinic (Ed). Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium (1545 - 1546). Vienna, Austria: DAAAM International Vienna

Sahno, J.; Savimaa, R.; Kangilaski, T.; Opik, R.; Maleki, M.; Machado, V-C. (2011). Data Mart framework for production route selection. Branko Katalinic (Ed). Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium (1543 - 1544). Vienna, Austria: DAAAM International Vienna

Kangilaski, T. (2012). Maturity Models as Tools for Focal Player Forming Virtual Organizations. Liu Pei (Ed). Management, Manufacturing and Materials Engineering (829 - 832). Trans Tech Publications, Switzerland

• *Automaatjuhtimise ja süsteemianalüüsi õppetool*

ETF8738

J. Belikov, E. Petlenkov. "Region of admissible values for discrete-time nonlinear control system linearized by output feedback," In Proc. of the 18th IFAC World Congress, Milano, Italy, August 28 - September 2, 2011, pp. 209-214.

I. Artemchuk, E. Petlenkov, F. Miyawaki. „Neural Network based System for Real-time Organ Recognition during Surgical Operation," In Proc. of the 18th IFAC World Congress, Milano, Italy, August 28 - September 2, 2011, pp. 6478-6483.

K. Vassiljeva, J. Belikov, and E. Petlenkov. "Genetic algorithm based structure identification for feedback control of nonlinear MIMO systems," In Abdelhamid Bouchachia, editor, Adaptive and Intelligent Systems: Second International Conference, ICAIS 2011, Klagenfurt, Austria, September 6-8, 2011. Springer, Lecture Notes in Artificial Intelligence, 2011, pp. 215-226.

J. Belikov, E. Petlenkov. Neuro-fuzzy dynamic pole placement control of nonlinear discrete-time systems. In 2011 International Joint Conference on Neural Networks, San Jose, California, July 31 - August 5 2011, pp 1577–1582.

A. Tepljakov, J. Belikov, E. Petlenkov. "FOMCON: Fractional-order modeling and control toolbox for MATLAB," In Proc. of the 18th International Conference Mixed Design of Integrated Circuits and Systems, MIXDES 2011, Gliwice, Poland 16 - 18 June, 2011, pp. 684-689.

• *Siduteooria ja –disaini õppetool*

Udal, A.; Kukk, V. (2011). An Engineering Approach to Time-Frequency Uncertainty Criteria. Electronics and Electrical Engineering, 6 pages [ilmumas]

Kaevand, T.; Kalda, J.; Kukk, V.; Öpik, A.; Lille, Ü. (2011). Correlation of the morphology and electrical conductivity in thin films of PEDT/PSS complex: an integrated meso-scale simulation study. Molecular Simulation, 37(6), 495 - 502.

2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

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

2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

Proaktiivsus ja situatsiooniteadlikkus / *Proactivity and situation-awareness* / (SF0140113As08, 01.01.2008-31.12.2013, 142 300 eurot, teema juht: professor Leo Mõtus)

Iseorganiseeruv intelligentne vahevara platvorm tootmis- ja logistikaettevõtete jaoks /*Self-organizing middleware platform for ad-hoc networks in the domain of manufacturing and logistics*/ (ARTEMIS, projekt SIMPLE /GART5, 01.05.2010 - 30.04.2013, 97 260 eurot, vastutav täitja: prof. Leo Mõtus)

Ajatundlike protsesside ja ilmneva käitumise modelleerimine multifunktsionaalsetes ja virtuaalorganisatsioonides / *Modelling of time-sensitive processes and emergent behaviour in multi-functional and virtual organisations* / (ETF grant G7693, 01.01.08 - 31.12.11, 9 091 eurot, vastutav täitja: van.teadur Raul Savimaa)

Keeruliste mittelineaarsete süsteemide juhtimine ja analüüs tehisintellekti meetoditega /*Artificial intelligence methods based analysis and control of complex nonlinear systems*/ (ETF grant G8738, 01.01.11 - 31.12.13, 6 000 eurot, vastutav täitja: dots. Eduard Petlenkov)

2.6 Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

Teaduskorralduslik tegevus

Prof. Leo Mõtus:
Eesti Teaduste Akadeemia - peasekretär
Integrated Computer - Aided Engineering (IOS Press) - *Member of the Editorial Advisory Board*
Eesti Teaduste Akadeemia Kirjastus, Proceedings of the Estonian Academy of Sciences, Estonian Journal of Engineering - toimetaja (*computer and systems science*)
Eesti Teaduste Akadeemia - liige
SA Eesti Teadusfondi nõukogu - vabaliige
The Institution of Engineering and Technology (IET) - liige
Kaitseministeeriumi Teadusnõukogu - aseesimees

Van.teadur Igor Astrov:
Institute of Electrical and Electronics Engineers, Inc. (IEEE) - vanem liige (*Senior member*)
The International Institute of Informatics and Systemics, USA (IIIS) - liige
IASTED International Conference on Automation, Control, and Information Technology - Control, Diagnostics, and Automation -*Member of the International Program Committee*

Van.teadur Andres Udal:
Infotehnoloogia ja Telekommunikatsiooni Kutsenõukogu - liige (Eesti Kõrgkoolide, Teadus- ja Arendusasutuste Ametiliitude Ühendus UNIVERSITAS esindaja)

Van.teadur Jürgo-Sören Predenile määrati SA Tallinna Tehnikaülikooli Arengufondi poolt 2011. aastal Akadeemik Boris Tamme nimeline stipendium (6 400 eurot).

Prof. Ennu Rüstern:
Institute of Electrical and Electronics Engineers, Inc. (IEEE) - liige
The Institution of Engineering and Technology (IET) - liige
Eesti Infotehnoloogia ja Telekommunikatsiooni Liit - TTÜ esindaja
EKKA - üleminekuhindamise ekspertgruppide (informaatika ja infotehnoloogia, matemaatika ja statistika) liige ja / või esimees
Tallinna Tehnikaülikooli valitsus - liige
Tallinna Tehnikaülikooli nõukogu - liige
Tallinna Tehnikaülikooli teaduskomisjon - liige
Tallinna Tehnikaülikooli akadeemiline komisjon - liige
Eesti Süsteemiinseneride Selts - liige

Dots. Boris Gordon:
European Society for Engineering Education (SEFI), Working Group on Ethics in Engineering Educations (EiEE) - liige

Dots. Eduard Petlenkov:
Info- ja kommunikatsioonitehnoloogia doktorikool – projektijuht

Prof. Vello Kukk:
Institute of Electrical and Electronics Engineers, Inc. (IEEE) - liige
IEEE Estonia Section, Education Society Chapter – *Chair* (esimees)

2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused *(Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel)*

- Haridus- ja Teadusministeerium

sihtfinantseeritavad teemad:

- T113A, Proaktiivsus ja situatsiooniteadlikkus, Mõtus Leo

baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):
riiklikud programmid:

- Teiste ministeeriumide poolt rahastatavad riiklikud programmid:

- Uurija-professori rahastamine:

- SA Eesti Teadusfond

grandid:

- ETF7693, Ajatundlike protsesside ja ilmneva käitumise modelleerimine multifunktsionaalsetes ja virtuaalorganisatsioonides, Savimaa Raul
- ETF8738, Artificial intelligence methods based analysis and control of complex nonlinear systems, Eduard Petlenkov

ühisgrandid välisriigiga:

- GART5, Iseorganiseeruv intelligentne vahevara platvorm tootmis- ja logistikaettevõtete jaoks, Mõtus Leo

järeldoktorite grandid (SA ETF ja Mobilitas):
tippteadlase grandid (Mobilitas):

- Ettevõtluse Arendamise SA

eeluuringud:
arendustoetused:

- SA Archimedesega sõlmitud lepingud

infrastruktuur (nn „mini-infra“, „asutuse infra“):

– AP113A, Proaktiivsus ja situatsiooniteadlikkus, Mõtus Leo

Eesti tippkeskused:
riiklikud programmid:
muud T&A lepingud:

- SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:

- Siseriiklikud lepingud:

– Lep9047, Multihop spontaanvõrkude uurimine, Pahtma Raido
- EITSA10 Kompetentsipõhise õpikeskkonna arendus ning selle laborikeskkonna uuendamine, Vello Kukk

- EL Raamprogrammi projektid:

- Välisriiklikud lepingud:

2.8 Struktuuriüksuse töötajate poolt avaldatud sihtfinantseeritava teadusteema taotlemisel arvestatavad eelretsenseeritavad teaduspublikatsioonid *(ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1).*

1.1

Udal, A.; Kukk, V. (2011). An Engineering Approach to Time-Frequency Uncertainty Criteria. Electronics and Electrical Engineering, 6 pages [ilmumas]

Kaevand, T.; Kalda, J.; Kukk, V.; Öpik, A.; Lille, Ü. (2011). Correlation of the morphology and electrical conductivity in thin films of PEDT/PSS complex: an integrated meso-scale simulation study. Molecular Simulation, 37(6), 495 - 502.

Riid, A.; Rüstern, E. (2011). Identification of transparent, compact, accurate and reliable linguistic fuzzy models. Information Sciences, 183(20), 4378 - 4393.

1.2

Aruväli, T.; Serg, R.; Preden, J.; Otto, T. (2011). In-process determining of the working mode in CNC turning. Estonian Journal of Engineering, 17(1), 4 - 16.

Astrov, I.: Pedai, A. (2011). Motion control of TUAV having eight rotors for enhanced situational awareness. Proceedings of the World Academy of Science, Engineering and Technology, 60, 694 - 701.

1.3

Savimaa, R.; Tenno, A.; Moora, P. (2011). Protsesside ja ilmneva käitumise modelleerimine siseturvalisuse valdkonnas. Sisekaitseakadeemia Toimetised, 10, 40 - 65.

2.1

2.2

3.1

Savimaa, P.; Kangilaski, T.; Polyantchikov, I. (2011). A framework for time-aware change management in virtual enterprises. Branko Katalinic (Toim.). Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium (1545 - 1546). Vienna, Austria: DAAAM International Vienna

Sahno, J.; Savimaa, R.; Kangilaski, T.; Opik, R.; Maleki, M.; Machado, V-C. (2011). Data Mart framework for production route selection. Branko Katalinic (Toim.). Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium (1543 - 1544). Vienna, Austria: DAAAM International Vienna

Astrov, I.; Pedai, A. (2011). Flight trajectory control of an eight-rotor UAV for enhanced situational awareness. N. Mastorakis, V. Mladenov, Z. Bojkovic, F. Topalis, K. Psarris, A. Barbulescu, H.R. Karimi (Toim.). Recent Researches in System Science (77 - 82).WSEAS

Riid, A.; Rüstern, E. (2011). Interpretability, Interpolation and Rule Weights in Linguistic Fuzzy Modeling. A.M. Fanelli, W. Pedrycz and A. Petrosino (Toim.). Fuzzy Logic and Applications. Proceedings of the 9th International Workshop WILF 2011 (91 - 98).Springer Verlag

Rannat, K.; Meriste, M.; Helekivi, J.; Kelder, T. (2011). Models of Indoor Environments –a Generic Interactive Model for Design and Simulation of Building Automation. Bhatt, M.; Guesgen, H. (Toim.). Situational Awareness for Assistive Technologies (40 - 60).IOS Press [ilmumas]

Astrov, I.; Pedai, A. (2011). Situational awareness based flight control of a four-rotor type UAV. V. Vasek, Y. Shmaliy, D. Trcek, N.P. Kobayashi, R.S. Choras, Z. Klos (Toim.). Recent Researches in Automatic Control (63 - 68).WSEAS

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3.3

4.1

5.1

2.9 Struktuuriüksuses kaitstud doktoriväitekirjade loetelu

Martin Jaanus, automaatikainstituut
Teema: *The Interactive Learning Environment For Mobile Laboratories* (Interaktiivne õpikeskkond mobiilsetele laboritele)
Juhendaja: prof Vello Kukk
Kaitses: 10.06.2011
Omistatud kraad: filosoofiadoktor (arvuti- ja süsteemitehnika)

2.10 Struktuuriüksuses järeldoktorina T&A-s osalenud isikute loetelu *(ETIS-e kaudu esitatud taotluste alusel)*

2.11 Struktuuriüksuses loodud tööstusomandi loetelu

3. Struktuuriüksuse infrastruktuuri uuendamise loetelu

- Spektraalanalüsaator Tektronix, 23.02.2011, 19 834 €
- Arupuru uurimiskomplekt, 18.03.2011, 20 452 €