GDAŃSK UNIVERSITY OF TECHNOLOGY

Department of Robotics & Decision Systems
Faculty of Electronics Telecommunications and Informatics
Narutowicza 11 / 12
80 - 233 Gdańsk
fax 48 58 348 6373

prof. Zdzisław Kowalczuk
head of the department
tel./fax (48) 58 347 2018
e-mail kova@pg.gda.pl
tel. (48) 58 347 2289
e-mail ksdr@eti.pg.edu.pl

Master Thesis

in

Automatic Control and Robotics

of

The Department of Robotics and Decision Systems

2022/2023

All the diploma projects given in the Polish version can be performed and edited in English. **Below you can find few samples of MSC Thesis in English**

Master Thesis Subject (English)	**Modeling and simulation of interactive capabilities of a mobile robot in the environment**
Temat w języku pol.	*Modelowanie i symulacja możliwości interaktywnych robota mobilnego w otoczeniu*
Supervisor	prof. dr hab. inż. Zdzisław Kowalczuk
Consultant	dr inż. Jakub Wszołek
Aims	In this project the student analyzes the issue of building a semantic model for the interaction of a robot-explorer with the real world. To enable more complete functionality, the hierarchical navigation structure is being replaced by an ontology that also takes into account the robot navigation aspect and is open to modeling other aspects of the real world.
Tasks	1. Review of literature solutions, 2. Development of an ontology - methods of describing the environment, 3. Development of the implementation of the selected solution, 4. Tests and development of results.
Literature	1. G. Kim, I. Suh, and H. Suh, “Ontology-based unified robot knowledge for service robots in indoor environments,” IEEE Trans. on Systems Man and Cybernetics - Part A, vol. 41, pp. 492–509, 2011. 2. E. Scioni et al., “Hierarchical hypergraphs for knowledge-centric robot systems: a composable structural meta model and its domain specific language NPC4, J.SE for Robotics, vol. 7, no. 1, pp. 55–74, 2016. 3. A. Rosinol et. al. … and L. Carlone, “Kimera: from slam to spatial perception with 3d dynamic scene graphs. arXiv preprint:2101.06894 (2021). 4. Faiza Gul et al., A comprehensive study for robot navigation techniques, DOI:10.1080/23311916.2019.1632046 (2019).
Number of contractors	**1**
Comments	**ZKe1:**

Master Thesis Subject (English)	**SLAM implementation on mobile robot**
Master Thesis Subject (Polish)	*Wdrożenie SLAM na robocie mobilnym*
Supervisor	prof. dr hab. inż. Zdzisław Kowalczuk
Consultant	mgr inż. Marlena Gruba
Aims	Mobile robot must be constructed and SLAM algorithm implemented.
Tasks	1. Robot construction. 2. Literature overview. 3. SLAM algorithm implementation. 4. Tests.
Literature	1. H. Durrant-Whyte and T. Bailey, "Simultaneous localization and mapping: part I," in IEEE Robotics & Automation Magazine, vol. 13, no. 2, pp. 99-110, June 2006, doi: 10.1109/MRA.2006.1638022.
Number of contractors	1 person
Comments	**ZKe2:**

Master Thesis Subject (English)	**Designing dynamic system drivers based on the use of Q-learning**
Master Thesis Subject (Polish)	*Projektowanie prostego sterownika układów dynamicznych z wykorzystaniem Q-learningu*
Supervisor	prof. dr hab. inż. Zdzisław Kowalczuk
Consultant	dr inż. Mariusz Domżalski
Aims	Application of a simplified version of the controller self-improvement method based on Q-learning control strategies. The Q-learning method can be used to design an improved modelless direct control algorithm with a reference control trajectory (PI), which also has a simplified version (in terms of computational complexity; number of tuning parameters and dimensionality of the Q matrix). Appropriate initialization of the Q matrix allows for shock-free switching from the existing PI controller (with defined PI tuning parameters and sampling time). The learning process can be based on intended setpoint changes or load disturbances.
Tasks	1. Analysis of the Q-learning method, 2. Development of a design algorithm, 3. Conducting tests, 4. Elaboration of the results.
Literature	1. Stebel K. Practical aspects of the model-free learning control initialization. 20th International Conference on Methods and Models in Automation and Robotics (MMAR), 2015, pp.453-458. 2. Musiał J., Stebel K., Czeczot J. Self-improving controller for a class of dynamical processes based on Q-learning technique. Archives of Control Sciences, 2021, pp. 527-55.
Number of contractors	**1**
Comments	**ZKe3:** Working with elements of mathematical modeling.

Master Thesis Subject (English)	**A visual system for the navigation of a mobile robot**
Master Thesis Subject (Polish)	*Wizualny system dla celów nawigacji robota mobilnego*
Supervisor	prof. dr hab. inż. Zdzisław Kowalczuk
Consultant	mgr inż. Jan Glinko, dr inż. M. Domżalski
Aims	Development of a visual navigation system for a mobile robot operating in an indoor environment, which includes mapping / SLAM (enabling the recognition of obstacles) and generating the trajectory of the movement of a real mobile robot. It is worth considering the use of the Gaussian method of raycasting, then in the process of analyzing the paths possible to reach the destination point, one can estimate the density of the target function distribution.
Tasks	1. Literature review of solutions and algorithms, 2. Development of a mapping method, 3. Development of a path planning method related to point 2.4. Conducting tests, 5. Elaboration of the results.
Literature	1. Takayuki Osa. Multimodal trajectory optimization for motion planning. The International Journal of Robotics Research, 39(8):983–1001, 2020. 2. Wonteak Lim et al. Hybrid trajectory planning for autonomous driving in on-road dynamic scenarios. IEEE Transactions on Intelligent Transportation Systems, 22(1):341–355, 2019.
Number of contractors	**1**
Comments	**ZKe4:** Working with elements of mathematical statistics.

Master Thesis Subject (English)	**Analysis of the structure of datasets from the point of view of the effectiveness of teaching deep neural networks**
Master Thesis Subject (Polish)	*Analiza struktury zbiorów danych z punktu widzenia skuteczności uczenia głębokich sieci neuronowych*
Supervisor	prof. dr hab. inż. Zdzisław Kowalczuk
Consultant	mgr inż. Jan Glinko
Aims	The databases used play a key role in data-driven approaches such as neural network training. Dataset characteristics such as diversity and balance are important here, as well as teaching positive and negative cases. Research studies of various cases should be carried out and practical conclusions on how to generate such databases should be presented..
Tasks	1. Review of the subject literature, 2. Implementation of selected methods and datasets, 3. Carrying out training processes (ANN/DNN), 4. Presentation of the results..
Literature	1. T. Mensink et al.: Factors of influence for transfer learning across diverse appearance domains and task types. arXiv preprint arXiv:2103.13318 (2021). 2. V. Cheplygina: Cats or CAT scans: Transfer learning from natural or medical image source data sets? Current Opinion in Biomedical Engineering 9, 21-27, 2019. 3. H. Bao, D. Li, and W. Furu: Beit: Bert pre-training of image transformers. arXiv preprint arXiv:2106.08254 (2021) 4. Z. Kowalczuk, J. Glinko: Training of deep learning models using synthetic datasets, 15th IC on Diagnostics of Processes and Systems, DPS'2022, ref. no. 111, 2022.
Number of contractors	**1**
Comments	**ZKe5:**

Master Thesis Subject (English)	**Modeling processes using genetic programming**
Master Thesis Subject (Polish)	*Modelowanie procesów za pomocą programowania genetycznego*
Supervisor	dr inż. Tomasz Białaszewski
Consultant	
Aims	The aim of the work is to develop genetic programming algorithms for a wide class of system modeling tasks. Implementation of the considered approach should be done in the Racket environment.
Tasks	1. Carrying out bibliographic searches. 2. Development and implementation of genetic programming algorithms 3. Carrying out appropriate simulation experiments 4. Presentation of numerical results 5. Conclusions (advantages, limitations, e.t.c.)
Literature	1. https://racket-lang.org/ 2. Koza, J.R. (1992). Genetic Programming: On the Programming of Computers by Means of Natural Selection, MIT Press
Number of contractors	1 person
Comments	**TBe1:**

Master Thesis Subject (English)	**Team strategies in the problems of multi-objective optimization**
Master Thesis Subject (Polish)	*Strategie zespołowe w problemach optymalizacji wielokryterialnej*
Supervisor	dr inż. Tomasz Białaszewski
Consultant	
Aims	The aim of the work is to develop team strategies algorithms for a wide class of multi-objective optimization tasks. Implementation of the considered approach should be done in the MATLAB environment.
Tasks	1. Carrying out bibliographic searches. 2. Development and implementation of team strategies algorithms 3. Carrying out appropriate simulation experiments 4. Presentation of numerical results 5. Conclusions (advantages, limitations, e.t.c.)
Literature	1. *Engelbrecht, A. (2005). Fundamentals of Computational Swarm Intelligence. Wiley & Sons* 2. Coello C.C.A., Lamont G.B., Van Veldhuizen D.A., 2007. Evolutionary algorithms for solving multi-objective problems, *Genetic and Evolutionary Comutation,* (2nd edition). Springer, Berlin.
Number of contractors	1 person
Comments	**TBe2:**

Master Thesis Subject (English)	**Identification of system dynamics using neural differential**
Master Thesis Subject (Polish)	*Identyfikacja dynamiki systemu za pomocą neuronowych równań różniczkowych*
Supervisor	dr inż. Mariusz Domżalski
Consultant	
Aims	The aim of the thesis is to investigate neural differential equations and their potential application for identification of the dynamics of systems described by ordinary differential equations. Networks learning the dynamic based on observation should be implemented for several selected models of dynamic systems (with different degrees of complexity, linear and non-linear, and chaotic). The research should include a comparison to the classical methods of identification of the parameters of differential equations and should include, for example, a study on the impact of observation noise on the effectiveness of the implemented algorithms.
Tasks	1. Literature review. 2. Implementation of selected algorithms 3. Research on the effectiveness and sensitivity of algorithms 4. Analysis of the results and conclusions
Literature	1. Neural Ordinary Differential Equations, Ricky T. Q. Chen et al., 32nd Conference on Neural Information Processing Systems (NeurIPS 2018), Montréal, Canada 2. Internet
Liczba wykonawców	1 person
Uwagi	**MDe1:**

Master Thesis Subject (English))	**A universal educational set for modelling and parameter identification of plants in control**
Master Thesis Subject (Polish)	*Uniwersalny zestaw edukacyjny do modelowania i identyfikacji parametrycznej obiektów w układach sterowania*
Supervisor	J. Kozłowski, PhD
Consultant	
Aims	Student has to increase his knowledge on modelling of continuous systems (i.e. differential equations, state-space models, etc.) and proper estimation schemes. Hardware part with analog devices (e.g. DC engines) has to be assembled. Yet, on-line presentation (PC screen) of estimation results has to be available in the ultimately manufactured set.
Tasks	1. Get familiar with the literature on modelling of non-trivial continuous-time automation systems. 2. Implement and verify numerically the selected schemes of parameter estimation. 3. Design and implement hardware part of the educational set.
Literature	1. Ljung L.: System identification. Theory for the user. Prentice-Hall Inc., Englewood Cliffs, New Jersey, USA, 1987 2. Unbehauen H., Rao G.P.: Continuous-time approaches to system identification - a survey. Automatica, vol. 26, 1990
Number of authors	1 person
Comments	**JKe1:**

Master Thesis Subject (English)	**Using neural network trained on the animation of intra-oral scenes for semantic segmentation of real video**
Master Thesis Subject (Polish)	*Wykorzystanie sieci neuronowej trenowanej na animacji przedstawiającej wnętrze jamy ustnej do segmentacji semantycznej rzeczywistego wideo*
Supervisor	dr hab. inż. Tomasz Stefański
Consultant	mgr inż. Piotr Kopa Ostrowski
Aims	The aim of the work is to verify to what extent it is possible to use models trained for the problem of semantic segmentation on an animated sequence for real video. The existing software enables the automatic generation of animations with different types of markings (segmentation masks, optical flow, etc.). The possibility of using this type of data could significantly reduce the costs of annotation.
Tasks	1. Preparation of the oral cavity interior animation. 2. Record a video showing the inside of the mouth or find data with such sequences. 3. Preparation of markings for validation. 4. The use of animated sequences with automatically generated markings to train neural network models for the problem of semantic segmentation. 5. Development of methods to improve the operation of the network.
Literature	1. Chen, Liang-Chieh, et al. "Deeplab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected crfs." IEEE transactions on pattern analysis and machine intelligence 40.4 (2017): 834-848.
Number of contractors	1 osoba
Comments	**TSe1:**

Master Thesis Subject (English)	**Analysis of the impact of regularisation function enforcing rotation and flip invariance on denoising quality and pruning possibilities.**
Master Thesis Subject (Polish)	*Analiza wpływu funkcji regularyzacyjnej redukującej wpływ przekształceń geometrycznych na jakość odszumiania oraz możliwości zmniejszenia rozmiaru sieci*
Supervisor	dr hab. inż. Tomasz Stefański
Consultant	mgr inż.Piotr Kopa Ostrowski
Aims	The aim of the work is to check whether training of the neural network with the use of an additional loss function limiting the impact of geometric transformations will contribute to the improvement of the quality of noise reduction algorithms. An additional element is to verify whether the network trained in this way will allow for a more effective reduction of the size of the neural network by reducing the number of channels in the convolutional layers.
Tasks	1. Train the model for the noise reduction problem without using additional regularization functions. 2. Train the model with the use of an additional regularization function reducing the influence of geometrical transformations. 3. Analyse convolutional layers of trained models in terms of their relation to the geometric transformations of the input. 4. Apply reduction in size for both models. 5. Compare the results.
Literature	1. Tassano, Matias, et al. "Fastdvdnet: Towards real-time deep video denoising without flow estimation." IEEE/CVF Conference on Computer Vision and Pattern Recognition 2020.
Number of contractors	1 osoba
Comments	**TSe2:**