

SIMEON NEDELICHEV

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EDUCATION

Innopolis University

Present

PhD in Computer Science (Robotics track).
Institute of robotics and computer vision

Korea University of Technology and Education

February 2019

Master of Engineering.

GPA: 4.45/4.5 (98/100)

Thesis title:

“Design of Robotic Gripper with Constant Transmission Ratio Based on Twisted String Actuator”

Department of Mechanical Engineering

Moscow State Technological University STANKIN

June 2018

Master of Engineering, Computer technologies in robotics and mechatronics

GPA: 4.9/5 (98/100)

Thesis title: “The Dynamics of Controlled Motion of Industrial Robots”

Department of Robotics and Mechatronics

Moscow State Technological University STANKIN

June 2016

Bachelor of Engineering, Development and application of robotic systems

GPA: 4.35/5 (87/100)

Thesis title: “Development and research of dynamic model of robot manipulator”

Department of Robotics and Mechatronics

WORKING EXPERIENCE

Center for Technologies in Robotics and Mechatronics Components

September 2019 - Present

Junior Researcher

Mathematical modeling, identification and control of Twisted String Actuators. Energy based nonlinear control and estimation. Optimal nonlinear control and trajectory optimization over mechanical systems. Mechanical and Electrical prototyping.

BioRobotics laboratory of Korea University of Technology and Education

March 2017 - June 2019

Research Assistant

Analysis and control TSA. Prototyping TSA driven robotic systems. Development and hardware implementation of advanced non-linear control algorithms.

TECHNICAL SKILLS

Programming Languages

Python, C/C++, Bash

Embedded systems

STM32, ARM, ESP32, PICO (MicroPython, HAL, FreeRTOS, mbed)

CAD

SolidWorks

Software

LaTeX, Linux, ROS

ACADEMIC INTERESTS

Nonlinear control theory, System identification, Digital and Discrete control, Adaptive and Robust control, Dynamical Systems, Analytical mechanics, Constrained mechanics, Applications of Convex Optimization to Control Theory.

TEACHING EXPERIENCE

Innopolis University

September 2019 - Present

Teaching Assistant

September 2019 - April 2022

- *Linear Control Theory* [BS S21] : The basics of linear control theory, developed the practical part of the course, labs, and tutorials
- *Fundamentals of Robot Control* [MS F19-21]: The foundation of robot dynamics and control
- *Robotic Systems* [BS F21-22]: The practical course of sensing, actuators and control
- *Computational Intelligence* [BS S21] : Application of convex optimisation to robotic and control applications conducted
- *Advanced Robotics* [MS S21] : Advanced control methodologies over robotic systems, conducted seminars and labs

Instructor

April 2022 - Present

- *Applied Nonlinear Control* [BS S22] : The fundamentals of dynamical systems, analysis over non-linear differential equations, fundamental control techniques including sliding mode and adaptive designs

INDUSTRIAL PROJECTS

Autonomous Underwater Oil and Gas Pipelines Inspection

December 2021 - Present

Developed, the modular multiprocessing based software architecture, hardware (actuator, sensors) and simulator (gazebo and ODE) interfaces as well as fast communication channel (LCM). Implemented the robust controller and observer of underwater vehicle to ensure the accurate tracking of 6 DoF (position and orientation) trajectory in the presence of modelling uncertainties and external disturbances.

RESEARCH PROJECTS

Planning and Control over Quadraped Robots

Derived nonlinear trajectory optimization techniques to plan highly dynamical motion of quadraped while accounting for actuator and friction constraints. Implemented robust and adaptive controllers to ensure accurate tracking in presence of uncertainties.

Control and Design of Twisted Strings driven Haptic Interface

Participated in the design of 3 DoF antagonistic TSA driven haptic interface, developed multiprocessing software and hardware architecture as well as control system

Modeling Control and design of Twisted String Actuators

Derived several novel dynamics, stiffness and kinematics models and verified them experimentally. Developed and implemented various nonlinear control for accurate and high-bandwidth position tracking in case of uncertainty in dynamics and kinematics parameters.

Robotic Gripper based on Twisted String Actuator

Investigate a gripper design that, when driven by a twisted string actuator, exhibits nearly-constant transmission ratio throughout its motion range. This allows for design of a highly-compact, modular and efficient robotic gripper driven by a low-power motor.

Kinematic Calibration of Industrial Manipulators

Implemented several calibration techniques based on circle point analysis by spatial circle fitting that allow to estimate kinematic parameters of serial industrial manipulators.

PUBLICATIONS

Books:

- Gaponov I, **Nedelchev S**, Ryu JH. Twisted String Actuation Systems: Applications, Modelling, and Control, Elsevier (scheduled to be published in 2022)

Journals:

- **Nedelchev S**, Gaponov I, Ryu JH. Accurate Dynamic Modeling of Twisted String Actuators Accounting for String Compliance and Friction. *IEEE Robotics and Automation Letters*. 2020 Jan 30;5(2):3438-43.
- **Nedelchev S**, Skvortsova V, Guryev B, Gaponov I, Ryu JH. On Energy-Preserving Motion in Twisted String Actuators. *IEEE Robotics and Automation Letters*. 2021 Jul 16.

Conferences:

- **Nedelchev S**, Gaponov I, Ryu JH. High-Bandwidth Control of Twisted String Actuators. In 2019 International Conference on Robotics and Automation (ICRA) 2019 May 20 (pp. 5359-5364). IEEE.
- **Nedelchev S**, Gaponov I, Ryu JH. Design of Robotic Gripper with Constant Transmission Ratio Based on Twisted String Actuator: Concept and Evaluation. In 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2018 Oct 1 (pp. 967-972). IEEE.
- Kosterev D, Vorotnikov A, **Nedelchev S**, Romash E, Poduraev Y. Development of 2-DOF Adaptive Mechatronic Device With Corrective Adjustment Of Laser Tracker Reflector For Industrial Robot Calibration. *Annals of DAAAM Proceedings*. 2017 Jan 28.
- Balakhnov O, **Nedelchev S**, Gaponov I. Preliminary Study on Slack-Free Model Predictive Control of Twisted String-Based Antagonistic Joints. In 2020 International Conference Nonlinearity, Information and Robotics (NIR) 2020 Dec 3 (pp. 1-5). IEEE.
- **Nedelchev S**, Kirsanov D, Gaponov I. IMU-based Parameter Identification and Position Estimation in Twisted String Actuators. In 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2020 (pp. 6311-6317). IEEE.
- **Nedelchev S**, Kirsanov D, Gaponov I, Seong H, Ryu JH. On Smooth Time-Optimal Trajectory Planning in Twisted String Actuators. In 2021 IEEE International Conference on Robotics and Automation (ICRA) 2021 May 30 (pp. 10107-10113). IEEE.

ACHIEVEMENTS

- “Best master thesis award”, Korea University of Technology and Education, Thesis title: “Design of Robotic Gripper with Constant Transmission Ratio Based on Twisted String Actuator”
- First prize in Russian thesis competition “Be-First” 2018 in Computer and Information Technologies. Thesis title: “The Dynamics of Controlled Motion of Industrial Robots”

RELEVANT COURSEWORK

Haptics and telerobotics systems, Modeling and control, Optimal control, Model predictive control, Probabilistic Modeling, Applied Robotics, Nonlinear system control.