Selma **Musić**

Control & Robotics Engineering Scientist ·

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I am a researcher in the field of human-robot interaction, passionate about developing novel control strategies for physical interaction of robots with humans and environment. My expertise is in system dynamics, control, optimization, cooperative robot manipulation, teleoperation, and haptics. I am a goal-oriented, methodical person and I continuously expand and improve my knowledge and skill set.

Education

TUM Department of Electrical and Computer Engineering, Technical University of Munich — *Munich, Germany*

Dr.-Ing. in Electrical and Computer Engineering — *Jan 2015 - Jul 2021*

- Thesis Title: Shared Control for Human-Robot Team Interaction
- Grade: *summa cum laude*
- Developed a novel shared-control framework using nonlinear decoupling control, impedance control, adaptive control, and game-theory framework. Results validated in simulations, experiments, and user studies. The framework enables human-robot team interaction independent of the interaction interface and the robot system complexity.

Faculty of Electrical Engineering, University of Sarajevo — *Sarajevo, Bosnia & Herzegovina*

M.Sc. in Electrical Engineering — *Oct 2011 - Nov 2014*

- Department for Automatic Control and Electronics
- GPA: 9.89/10
- Thesis Title: Automated Insertion of Geophones using Lightweight Robots

Faculty of Electrical Engineering, University of Sarajevo — *Sarajevo, Bosnia & Herzegovina*

B.Sc. in Electrical Engineering — *Oct 2008 - Sep 2011*

- Department for Automatic Control and Electronics
- GPA: 9.33/10
- Thesis Title: Detection, Classification and Analysis of Transient Overvoltages in Distributive Power Systems Using Discrete Wavelet Transformations (DWT)

Experience

Stanford Robotics Lab, Department of Computer Science, Stanford University — *Stanford, California, USA*

Postdoctoral Scholar — *Nov. 2021 - Present*

- Leading and managing a *EU Marie Skłodowska-Curie Postdoctoral Grant HRI-CoDeOp*
- Developing a holistic, human-centric shared-control framework for human-robot collaboration that will consider the interaction on: (i) the cognitive/decision-making level for a dynamic role arbitration and conflict resolution, and (ii) the physical/operational level with human-in-the-loop and safety guarantees.

Chair of Information-oriented Control, Department of Electrical and Computer Engineering, Technical University of Munich (TUM) — *Munich, Germany*

Research & Teaching Assistant — *Jan. 2015 - Nov. 2021*

- Nov. 2020 - Jun. 2021: Led the execution of one workpackage within the *Horizon 2020 project ReHyb (Rehabilitation Based on Hybrid Neuroprosthesis)*. Developed a control architecture concept for shared control between patient and a hybrid exoskeleton. Implemented a shared-control approach that relies on impedance control using a haptic device as a prototypical hardware. Supervised a team of 3 PhD students within the project.
- Jan 2015 - Nov 2017: Worked on the *EU-FP7/2007-2013 project WearHap (Wearable Haptics for Humans and Robots)*. Developed a control architecture for adjustable team control between heterogeneous team members - humans and robots. Developed a software architecture for human-multi-robot interaction. Integrated various wearable command and feedback interfaces, developed by consortium partners, into the proposed control architecture and experimental setup with multiple mobile manipulators. Conducted experimental validation of wearable devices usability through user studies and statistical analysis. Demonstrated a live experiment at the final project meeting.
- Jan 2015 - Nov 2021: Teaching Assistant (see Teaching section.
- Supervised 5 Master's Theses, 4 Bachelor Theses, 1 student internship and 1 seminar work. See Advising & Mentoring section.

Stanford Robotics Lab, Department of Computer Science, Stanford University — *Stanford, California, USA*

Visiting Student Researcher — *Mar. 2018 - May 2018 & Jan. 2019*

- Collaborated with Prof. Dr. Oussama Khatib on the project titled *Shared-Control Architecture for Human-Robot Interaction through Haptic Devices*. Developed a shared-control approach for interaction between a human operator and multiple cooperating robots for a cooperative manipulation task.

Institute of Robotics and Mechatronics, German Aerospace Center (DLR) *Oberpfaffenhofen, Germany*

Working Student *Feb. 2014 - Sep. 2014*

- Conducted research was part of the project *The Helmholtz Alliance "Robotic Exploration Under Extreme Conditions – ROBEX"*. The aim was to achieve automatic deposition of seismic sensors (geophones) using a lightweight manipulator. Contributed to the project with a control approach for accurate insertion and positioning of geophones. This was achieved using a Cartesian impedance controller that relies on estimation of the soil parameters using the earth-moving equation and the Discrete Element Method (DEM). The experiments were performed with the DLR humanoid robot *Rollin' Justin*.

Research Department for Automated Optical Inspection, Robert Bosch GmbH *Schwieberdingen, Germany*

Working Student *Jul. 2013 - Dec. 2013*

- Implemented and evaluated machine learning algorithms for outlier detection in images of car engine parts with the aim of detecting faults during production. Methods used: Steerable Pyramid Decomposition, Principal Component Analysis (PCA), kernel based novelty detection method, and Gaussian Mixture Models (GMMs).

Skills

Programming	MATLAB & Simulink (expert), C++ (proficient), C (prior experience), Python (prior experience), C# (prior experience), Verilog (prior experience), VHDL (prior experience), Assembly (prior experience), Linux (proficient), CMake (proficient), Vim (prior experience), git (proficient), LaTeX(expert)
Robotics	KUKA collaborative robots, Panda (Franka Emika), Haptic devices (Force Dimension), wearable haptics
Control	PID control, force/torque control, impedance control, passivity-based control, nonlinear control, adaptive control, optimal control, game theory
Languages	Bosnian/Croatian/Serbian (native proficiency), English (full professional proficiency), German (professional working proficiency)

Honors & Awards

2021	**Outstanding Doctoral Dissertation**, Freunde der TUM e.V.	*Munich, Germany*
2020	**Marie Skłodowska-Curie Postdoctoral Fellowship**, European Commission	*Germany & USA*
2018	**Funding**, Bavaria California Technology Center (BaCaTeC)	*USA & Germany*
2017	**Award for Outstanding Performance**, TUM president Wolfgang A. Herrmann	*Munich, Germany*
2013	**Scholarship**, Internship Programme of German Business for the Countries of the Western Balkans	*Germany*
2011	**Best Bachelor Student Award**, Dean of Faculty of Electrical Engineering	*Sarajevo, B&H*

Teaching

Advanced Control and Robotics Laboratory

Master Course *2015, 2016, 2017*

Einführung in die Roboterregelung (Introduction to Robotic Control)

Bachelor Course *2015/16, 2016/17*

Praktikum Roboterregelung (Robot Control Laboratory)

Bachelor Course *2017/18, 2018/19*

Praktikum Regelung und Automation (Control and Automation Laboratory)

Master Course *2019/20*

Advising & Mentoring

Martin Angerer, Davide Zanellati, Ana Avdiaj, Elena Zennaro, Elena Zhelondz

Master's Theses *2016-2020*

Jarrat Ong, Edgar Ricardo Chavez Rosas, Amr Ezzat, Christian Schmidt

Bachelor Theses *2016-2018*

Martin Angerer, Sarah Buhlmann, Pablo Budde gen. Dohmann
Student Internships *2016-2017*

Invited Talks

Humanoids21 Conference *Munich, Germany*
Workshop Talk *Jul. 2021*
- Workshop title: Towards physical-social human-robot interaction.
- **Musić, S.** Haptic Control Sharing Based on Game-Theoretical Concepts.

54. Regelungstechnisches Kolloquium *Boppard, Germany*
Colloquium Talk *Mar. 2020*
- **Musić, S.** and Hirche, S. Shared Control for Haptic Human-Robot Interaction.

Opening of *The Munich School of Robotics and Machine Intelligence (MSRM)* *Munich, Germany*
Experimental Robot Demonstration *Oct. 2018*
- **Musić, S.**, B. g. Dohmann, P., and Hirche, S. Robot Team Teleoperation through Wearable Haptics.

IROS18 Conference *Madrid, Spain*
Workshop Talk *Oct. 2018*
- Workshop title: Haptic-enabled shared control of robotic systems: a compromise between teleoperation and autonomy.
- **Musić, S.** and Hirche, S. Shared Control for Semi-Autonomous Robot Team Teleoperation through Wearable Haptics.

Symposium on Networked Cyber-Physical Systems (NCPS) *Munich, Germany*
Poster Presentation *Sep. 2016*
- **Musić, S.** and Hirche, S. Networked Human-Robot Team Interaction.

Professional Activities

IFAC Conference
Session Co-Chair *Jul. 2020*

External Reviewer
Journals and Conferences *2015-*
- Control Theory: IFAC, ACC, CDC, Automatica
- Robotics: T-RO, AURO, RA-L, ICRA, IROS, Mechatronics, Humanoids

Courses, Certificates, & Projects

Coursera *Stanford University*
Machine Learning *Aug. 2022*

Publications

Journal Publications
- Endo, S., Fröhner, J., **Musić, S.**, Hirche, S., and Beckerle, P. (2020). Effect of External Force on Agency in Physical Human-Machine Interaction. Frontiers in human neuroscience, 14, 114.
- **Musić, S.**, Salvietti, G., B. g. Dohmann, P., Chinello, F., Prattichizzo, D., and Hirche, S. (2019). Human-Robot Team Interaction Through Wearable Haptics for Cooperative Manipulation. IEEE Transactions on Haptics, vol. 12, no. 3, pp. 350-362, 1 July-Sept. 2019, DOI: 10.1109/TOH.2019.2921565.
- **Musić, S.**, and Hirche, S. (2017). Control Sharing in Human-Robot Team Interaction. Annual Reviews in Control, 44, pp. 342-354. DOI: 10.1016/j.arcontrol.2017.09.017.

Conference Publications

- Alagi, H., Navarro, S. E., Hergenhan, J., **Musić, S.**, and Hein, B. (2020). Teleoperation with Tactile Feedback based on a Capacitive Proximity Sensor Array. 2020 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), pp. 1-6, DOI: 10.1109/I2MTC43012.2020.9128701.
- **Musić, S.**, and Hirche, S. (2020). Haptic Shared Control for Human-Robot Collaboration: A Game-Theoretical Approach. Proceedings of the 21st IFAC World Congress.
- **Musić, S.**, Prattichizzo, D. and Hirche, S. (2019). Human-Robot Interaction Through Fingertip Haptic Devices for Cooperative Manipulation Tasks. 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), pp. 1-7, DOI: 10.1109/RO-MAN46459.2019.8956350.
- **Musić, S.**, Khatib, O., and Hirche. S. (2018). Shared Control for Robot-Team Teleoperation. 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems, Workshop on "Haptic-enabled shared control of robotic systems: a compromise between teleoperation and autonomy". Short paper and poster presentation.
- **Musić, S.** and Hirche, S. (2018). Passive Noninteracting Control for Human-Robot Team Interaction. 2018 IEEE Conference on Decision and Control (CDC). December 2018, pp. 421-427. DOI: 10.1109/CDC.2018.8619289.
- **Musić, S.**, Salvietti, G., B. g. Dohmann, P., Chinello, F., Prattichizzo, D., and Hirche, S. (2017). Robot Team Teleoperation for Cooperative Manipulation using Wearable Haptics. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 2556-2563. DOI: 10.1109/IROS.2017.8206077.
- Angerer, M., **Musić, S.**, and Hirche, S. (2017). Port-Hamiltonian based Control for Human-Robot Team Interaction. IEEE International Conference on Robotics and Automation (ICRA), pp. 2292-2299. DOI: 10.1109/ICRA.2017.7989264.
- **Musić, S.** and Hirche, S. (2016). Classification of human-robot team interaction paradigms. 1st IFAC Conference on Cyber-Physical & Human-Systems (CPHS). IFAC-PapersOnLine, vol. 49, no. 32, pp. 42-47. DOI: 10.1016/j.ifacol.2016.12.187.
- Sieber, D., **Musić, S.**, and Hirche, S. (2015). Multi-robot manipulation controlled by a human with haptic feedback. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 2440-2446. DOI: 10.1109/IROS.2015.7353708.
- Leidner, D., **Musić, S.**, and Wedler, A. (2015). Robotic Deployment of Extraterrestrial Seismic Networks. Proceedings of the 13th Symposium on Advanced Space Technologies in Robotics and Automation (ASTRA).

Dissertation

- Musić, S. (2021). Shared Control for Human-Robot Team Interaction. Ph.D Dissertation. TUM Department of Electrical and Computer Engineering, Technical University of Munich.