

# AntunSkuric

PhD in physical human-robot interaction



## Personal Info

### location:

Bordeaux, France

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### website:

askuric.github.io

### Online Profiles:



### Languages:

**Croatian** - native  
**English** - proficient  
**French** - proficient

### I am passionate about:

playing guitar,  
reading,  
hiking,  
running and cycling,  
making things,  
creating and sharing  
educational projects

## Research Interests

- Physical human-robot interaction modeling
- Human and robot physical ability estimation
- Polytope algebra and computation
- Human centered robot control
- Optimal control strategies
- Quadratic programming (QP)

## Education

2020 - 2023

### PhD Thesis

PHYSICAL HUMAN-ROBOT INTERACTION

INRIA Bordeaux, AUCTUS team & University of Bordeaux, France

THESIS: A COUPLED VIEW OF THE PHYSICAL ABILITIES OF HUMAN-ROBOT DYAD FOR THE ONLINE QUANTITATIVE EVALUATION OF ASSISTANCE NEEDS

- Exploration of physical capabilities for physical-human robot interaction
- Design of human-centered robot control
- Project LiChIE in collaboration with **Airbus DS** (Defense and Space)
- Under supervision of Vincent Padois and David Daney.

2014 - 2017

### M.Sc. in Electrical Engineering

CONTROL THEORY AND MECHATRONICS

University of Zagreb, Faculty of Electrical Engineering and Computing

- Collaboration with **Robrt Bosch GmbH**, Stuttgart, Germany
- GPA: 4.5/5.0

2011 - 2014

### B.Sc. in Electrical Engineering

CONTROL THEORY

University of Zagreb, Faculty of Electrical Engineering and Computing

- GPA: 4.0/5.0 - ranked among the top 10% of my generation

## Honors and Awards

2021

### IEEE Transactions on Automation Science and Engineering Best Paper Award

IEEE TASE

For the paper: *A Recursive Watermark Method for Hard Real-Time Industrial Control System Cyber-Resilience Enhancement*

2019

### 1<sup>st</sup> at the RoboCup 2019 - Humanoid KidSize Soccer League

RoboCup

I had the opportunity to participate at the RoboCup 2019 held in Sidney, Australia as a part of the team **Rhoban**.

2016-2017

### Scholarship for Internship in Germany

Zoran Djindjic Foundation (DAAD)

- Awarded by German Academic Exchange Service (DAAD).

2016

### 1<sup>st</sup> place in competition Elektroboj

eStudent Zagreb

- Innovation competition founded by international student organisation eStudent.
- First place prize 1000€ and 1 year incubation for **GuitarFriend** project.

2015-2016

### 1<sup>st</sup> place in PLC+ competition

SIEMENS | EESTEC LC Zagreb

- Regional competition (Croatia, Slovenia and Serbia), organized by Eestec LC Zagreb, sponsored by **SIEMENS**.
- Winner two years in a row.

## Certificates

2023

### Modern Robotics by Northeastern University

Course 4: Robot Motion Planning and Control. Completed 4 week (30 hours) online course. [Certificate Link](#)

Coursera

2019

### PCB design in Altium Designer 2019

Completed 14.5 hours online course. [Certificate Link](#)

Coursera

2019

### Reinforcement Learning Spetialization by University of Alberta

Completed 4 course (16 week) online specialization. [Certificate Link](#)

Coursera

2018

### Machine Learning by Stanford University

Completed 8 week online course. [Certificate Link](#)

Coursera

# Publications

- 2023 **Pycapacity: a real-time task-space capacity calculation package for robotics and biomechanics**  
Submitted to: Journal of Open-Source Software, 2023  
**A Skuric**, V Padois, D Daney  
Easy to install and use python pip package implementing different physical ability metrics for humans and robots.  
[github](#)
- 2023 **Dynamics aware Cartesian wrench polytope estimation based on human musculoskeletal models**  
46th Congrès de la Société de Biomécanique  
**A Skuric**, V Padois, D Daney  
Human force capacity evaluation capable of taking in consideration the rigid-body dynamics effects.
- 2022 **Online task-space trajectory planning using real-time estimations of robot motion capabilities**  
Submitted to ICRA 2023  
**A Skuric**, N Torres Alberto, L Josph, V Padois, D Daney  
Online robot's motion capacity aware cartesian space motion planner.  
[pdf](#)
- 2022 **Approximating robot reachable space using convex polytopes**  
A15th International Workshop on Human-Friendly Robotics  
**A Skuric**, V Padois, D Daney  
A new strategy for reachable space approximation using convex polytopes.  
[gitlab](#), [pdf](#)
- 2022 **On-line feasible wrench polytope evaluation based on human musculoskeletal models: an iterative convex hull method**  
Accepted to IEEE ICRA 2022 & IEEE RA-L  
**A Skuric**, V Padois, N Rezzoug, D Daney  
A new efficient polytope evaluation algorithm for feasible wrench analysis of the human musculoskeletal models.  
[gitlab](#), [pdf](#), [pptx](#), [video](#)
- 2022 **SimpleFOC: A Field Oriented Control (FOC) Library for Controlling Brushless Direct Current (BLDC) and Stepper Motors**  
Journal of Open-Source Software, 2022  
**A Skuric**, H Bank, O Williams, R Unger, D Gonzalez  
[github](#), [pdf](#)
- 2021 **Common wrench capability evaluation of a human-robot collaborative system**  
46th Congrès de la Société de Biomécanique  
**A Skuric**, N Rezzoug, D Daney, V Padois  
A proposition of a formal technique for calculating joint wrench capacity of a human-robot collaboration, based on the wrench polytopes.  
[pdf](#)
- 2021 **On-line force capability evaluation based on efficient polytope vertex search**  
IEEE ICRA 2021  
**A Skuric**, V Padois, D Daney  
New on-line polytope vertex search algorithm optimised for force and velocity polytope evaluation of serial robots.  
[gitlab](#), [pdf](#), [video](#)
- 2020 **A Recursive Watermark Method for Hard Real-Time Industrial Control System Cyber-Resilience Enhancement**  
IEEE Transactions on Automation Science and Engineering  
Z Song, **A Skuric**, K Ji  
**Received the IEEE TASE best 2021 paper award, and featured in IEEE Spectrum**  
Novel recursive watermarking method for hard real-time networked control systems preventing man in the middle attacks.
- 2019 **Rhoban Football Club: RoboCup Humanoid KidSize 2019 Champion Team Paper**  
Robot World Cup  
L Gondry, L Hofer, P Laborde-Zubieta, Or Ly, L Mathé, G Passault, A Pirrone, **A Skuric**  
Description of the approaches and techniques used to win RoboCup 2019.

# Work Experience

2020 - 2023	<b>Teaching assistant</b> <b>UNIVERSITY OF BORDEAUX, ESNAM, ENSC</b> <ul style="list-style-type: none"><li>- Human-robot interfaces class - <i>École nationale supérieure de cognitive (ENSC)</i></li><li>- Mathematics and Informatics class - <i>École nationale supérieure d'arts et métiers (ENSAM)</i></li><li>- Embedded Systems class - <i>University of Bordeaux (ASPIC)</i></li></ul>	
2020 - 2023	<b>PhD candidate</b> <b>INRA BORDEAUX, TEAM AUCTUS</b> <ul style="list-style-type: none"><li>- Exploration of physical capabilities for physical-human robot interaction</li><li>- Project LiChIE in collaboration with <b>Airbus DS</b> (Defense and Space)</li><li>- Under supervision of <u>Vincent Padois</u> and <u>David Daney</u>.</li></ul>	
2020	<b>Freelancer</b> <b>UPWORK, SELF-EMPLOYED</b> <ul style="list-style-type: none"><li>- Fields: Control Engineering, Sensor Fusion for motion tracking and Software development. <u>UpWork profile link</u></li><li>- <b>Pollen robotics</b> - working on the inverse kinematics of <u>Reachy robot</u></li></ul>	
2019	<b>Research Engineer</b> <b>AIO PESSAC   PROJET NUMII®</b> <ul style="list-style-type: none"><li>- Human pose estimation algorithms based on RGB and Depth cameras</li><li>- Skeletal fusion algorithms</li><li>- Hardware, software and firmware development - prototyping</li></ul>	March - October
2018-2019	<b>Research Associate</b> <b>FACULTY OF ELECTRICAL ENGINEERING, UNIVERSITY OF ZAGREB</b> DEPARTMENT OF ELECTRIC MACHINES, DRIVES AND AUTOMATION <ul style="list-style-type: none"><li>- Distributed model predictive control (MPC) for Building management systems</li><li>- Advanced control algorithms for a reconfigurable three-wheeled vehicle</li><li>- Supervised by <u>Jadranko Matusko</u>, <u>Sandor Iles</u> and <u>Mario Vasak</u></li></ul>	July - March
2017-2018	<b>Graduate Internship - Control Engineering</b> <b>SIEMENS CT PRINCETON, USA</b> <ul style="list-style-type: none"><li>- Maintenance and enhancements of industrial embedded software (2 invention disclosures)</li><li>- Development of a novel watermarking algorithm for hard real-time control systems Engineering</li><li>- Supervised by <u>Kun Ji</u> and <u>Zhen Song</u></li></ul>	October - June
2016-2017	<b>GuitarFriend - Founder</b> <b>STUDENT START-UP INCUBATOR SPOCK, UNIVERSITY OF ZAGREB</b> GuitarFriend is an innovative device enabling people with hand disabilities to learn and play guitar. <ul style="list-style-type: none"><li>- Fully developed working proof of concept prototype<ul style="list-style-type: none"><li>• Mechanics - CAD, 3D print</li><li>• Electrics - Matlab, BLDC motors, Encoders, FOC</li><li>• Software - Python, Web</li></ul></li><li>- Product presented at <i>IDEA Knockout</i>, <i>LEAP summit</i>, <i>miPRO</i> and <i>TEDx</i>. <u>Facebook</u> <u>Videos</u></li></ul>	October - June
2016-2017	<b>Student Internship - Masters thesis</b> <b>BOSCH GMBH RENNINGEN, GERMANY</b> <b>Master's Thesis</b> (6 months) AUTOMATING OF AN ADAPTABLE FIXING DEVICE FOR CYBER PHYSICAL PRODUCTION SYSTEMS <ul style="list-style-type: none"><li>- Design and implementation of the complete control software stack for the given mechatronic device</li><li>- Design of an advanced user interface for high level control and process initialization of an industry 4.0 factory.</li></ul>	July - February

## Technical skills

### Programming languages

<ul style="list-style-type: none"><li>• Python</li><li>• C/C++</li><li>• Matlab / Simulink</li></ul>	<ul style="list-style-type: none"><li>• Java</li><li>• HTML/CSS/Javascript/SQL/php</li><li>• PLC programming (Step7, Ladder...)</li></ul>	<ul style="list-style-type: none"><li>• Robotic operating system (Linux)</li><li>• Git - collaborative development</li><li>• Embedded platforms (Arduino/stm32/esp32...)</li></ul>
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### Hands-on experience

<ul style="list-style-type: none"><li>• Biomechanical model manipulation</li><li>• Mechatronic design</li><li>• Control system design</li><li>• System identification</li></ul>	<ul style="list-style-type: none"><li>• Sensor Fusion</li><li>• Embedded Systems</li><li>• Robotics   Mobile/Manipulators</li><li>• PCB design</li></ul>	<ul style="list-style-type: none"><li>• CAD   3D printing   CNC</li><li>• Industrial Automation</li><li>• User Applications</li></ul>
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# Open-source projects

- 2021-now    **pycapacity: Real-time capable task-space capacity evaluation python module**  
*INRIA Bordeaux, AUCTUS team*  
The PYCAPACITY package provides a framework for the generic task-space capacity calculation for:
- Robotic serial manipulators - PYCAPACITY.ROBOT
  - Human musculoskeletal models - PYCAPACITY.HUMAN
- For more info about the theoretic and implementation details check the [documentation](#).
- 2020 - now    **SimpleFOCproject: Arduino Compatible Open Source Field Oriented Control (FOC) project**  
*Founder & Project Administrator*
- Demystifying the Field Oriented Control (FOC) algorithm for controlling brushless DC and stepper motors.
  - Supporting wide range different motors, position sensors, drivers and microcontrollers
  - Based on easy-to-use Arduino IDE
  - More than 500 community members
- Simple**FOC**project components:
- Simple**FOC**library
  - Simple**FOC**Shield
  - Simple**FOC**Balancer
  - Simple**FOC** Power**Shield**
- Simple**FOC**project links:
- [simplefoc.com](#)
  - [Youtube channel](#)
  - [Community forum](#)
  - [Documentation](#)
- 2019    **Inverted inertia pendulum**  
*Faculty of Electrical Engineering in Zagreb | Self initiated*
- Development of inertial force based inverted pendulum as a low-cost, testing platform for optimal control algorithms.
    - Mechanical design - CAD, 3D print
    - Electrical design - DC motors, Incremental encoder
    - Control design - Matlab, PID, LQR
  - Currently used for the Mechatronics class at the University of Zagreb. [Github](#) [YouTube](#) [Thingiverse](#) [Images](#)
- 2016    **Gibalo: Two wheeled inverted pendulum robot**  
*Faculty of Electrical Engineering in Zagreb | Self initiated | Funded Student Project*
- Development of balancing two-wheeled robot as a low-cost, testing platform for optimal control algorithms.
    - Mechanical design - CAD, 3D print
    - Electrical design - Stepper motors, Accelerometers
    - Control design - Matlab, PID, LQR, MPC
  - Candidate for Chancellor's Research Award for the year 2016.
  - Currently used as a part of a Mechatronics class at the University of Zagreb. [Github](#) [Google Play](#) [Images](#)