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Paulo Rezeck

Software Engineer / Ph.D. Student

Portfolio: rezeck.github.io
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I am a highly **motivated computer scientist** interested in solving real-world problems and challenges involving disruptive technologies such as **artificial intelligence, machine learning, computer vision, and robotics**. As an **expert in robotics**, I had the opportunity to develop **skills at both software and hardware** levels, involving embedded systems, sensor networks, and mechanical and electrical design. I participated in several R&D projects for the industry, developing prototypes of **tele-operated robotic systems and algorithms for detecting and tracking objects and people**. Such experiences improved my interpersonal communication, organization, and leadership skills.

Education

Doctor of Philosophy in Computer Science

06/2019 — 10/2022*

Universidade Federal de Minas Gerais (UFMG) — Brazil

UFMG is ranked as #1 Latin America CS program: http://csrankings.org/#/index?all&southamerica

Research area: Swarm Robotics, Artificial Intelligence and Probabilistic Graph Models
Advisor: Prof. Luiz Chaimowicz
Thesis: *A Stochastic Framework for Multi-Emergent Swarm Robotics Behaviors*

- **Robot swarm control** using probabilistic modeling using ROS middleware;
- **Development of a simulation environment** for swarms of robots using Gazebo;
- **Papers published and presented at the best robotics** world conferences (ICRA/IROS/RAL/AURO).

Master of Science in Computer Science

08/2016 — 02/2019

Universidade Federal de Minas Gerais (UFMG) — Brazil

Research area: Robot Design and Robotic Swarm
Advisor: Prof. Luiz Chaimowicz
Master's Dissertation: *HeRo: An Open Platform for Robotics Research and Education*

- **Low cost robot design and construction** using Autodesk F360 and Eagle;
- **MCU firmware implementation** using C/Wiring language for embedded systems.
- **Kinematic control, sensor fusion using Kalman filter, mapping, and localization**;

Bachelor of Science in Computer Science

08/2010 — 07/2016

Universidade Federal de Minas Gerais (UFMG) — Brazil

Research area: Robot Design and Robotic Swarm
Advisor: Prof. Luiz Chaimowicz
Bachelor's Dissertation: *Development of a Framework for Experiments with Robots Swarms.*

- Practice with with **embedded computer (Gumstick Overo) executing OS Yocto**;
- Practice with **firmware implementation and hardware protocol** (I2C, SPI, UART);

Master of Science/Internship in Computer Science

02/2014 — 09/2015

Eberhard Karls University of Tübingen — Germany

Program: Science without Borders
Research area: Robot Control, SLAM and Robot Vision

- Experience in **mobile robot control** (ackerman robot) and **robot vision and object identification**;
- Practice with **filtering and sensor fusion** (LiDAR, Odometry);
- Experience in **simultaneous localization and mapping** (SLAM);

Professional Experience

Tech Leader / Digital Inspection of Industrial Painting Activities based on Computer Vision
08/2020 — 07/2022

Petrobras / Universidade Federal de Minas Gerais (UFMG) — Brazil

Description: *Recognition of human actions during the industrial painting activity using deep learning approaches.*

- Technical leader of a team specialized in robotics and machine learning;
- Experience with neural networks for real-time **detection of human pose** (OpenPose/AlphaPose/PoseNet);
- Experience with neural networks for real-time **tracking of objects** (Deep SORT);
- Experience in **container software architecture** (Docker);
- Linux process communication and **algorithm optimization** (C++/Python/IPC/Socket/CUDA);

Robotics Engineer / Artificial Intelligence Robotic Racing
02/2019 — 04/2020

XQuad Team — Brazil / USA

Description: *Worked with a team specialized in UAV to create an AI for racing drones that can beat a human pilot. Awarded 7th/424 place at the Artificial Intelligence Robotic Racing (AIRR) competition.* [1]

- Worked with a team specialized in UAV to create an AI for racing drones that can beat a human pilot;
- Experience in **Linux embedded system and algorithm optimization** (C++/CMake);
- Experience with **visual odometry** (ORBSLAM2/ROVIO/VINS) and **object detection** algorithms (YOLO/OpenCV);
- **Awarded 7th/424 place** at the **Artificial Intelligence Robotic Racing** (AIRR) competition.

Student Researcher / Advanced Teleoperation of Excavators in the Mining Industry
10/2017 — 08/2020

Vale Institute of Technology (ITV) / Universidade Federal de Minas Gerais (UFMG) — Brazil

Description: *Develop a framework for excavator teleoperation using haptic technologies and visual immersion.*

- **Modeling/Construction of robotic excavator** prototype using off-the-shelf parts and 3D printing;
- Robotic manipulator **haptic control** (C++/ROS/MOVEit);
- **Construction/Control of a robotic head-like device** for tele-immersion (C++/OpenCV/ROS);
- Development of a **master/slave systems** for teleoperation (Unity/WebRTC/ROS);

Student Researcher/ Cooperative Magnetic-Mapping using Small UAVs
09/2015 — 08/2017

Vale Institute of Technology (ITV) / Universidade Federal de Minas Gerais (UFMG) — Brazil

Description: *Control of multiple drones creating a magnetic mapping for planning the ore deposits exploration.*

- Experience in **piloting and control drones**;
- Experience with **Linux embedded systems**, image creation, and kernel compiling;
- Implementation of a **visual interface for real-time control of drones** (Python/JavaScript/QT);
- Implementation of applications for **custom data acquisition and signal processing** (Android Studio/Java/C++);

[1] XQuad 7th place in AIRR World Championship: https://xquadufmg.com

Languages

• English (proficient) • German (limited working proficiency) • Portuguese (native speaker)

Other Professional Qualifications

Operating Systems	Practical experience with **Linux**; integrated peripherals; conceptual understanding of sysfs, udev and dbus; controlling and automating LINUX processes using shell script; etc.
Linux Network	Intermediate skills: **networking tools**, routing packets, networking diagnostic procedures, and firewalls configuration under Linux environments.
Programming	Python, C, C++, Java, MATLAB. Experience with **embedded devices and optimized programming**. Experience with good programming practices, clean code, debugging, and testing;
Developer Practice	Experience with version control software (**Git**/SVN), agile software development (**Scrum** framework) and project report writing; UI design (**Qt**) and mobile (**Android Studio**);
Hardware	Practice with C/Wiring microcontroller programming, especially **Arduino**, **ESP8266**/**ESP32** and PIC; hardware protocol (I2C, SPI, UART); **Circuit design and Assembly**;
Robotics	Mechanical and electrical design (Autodesk Fusion/Eagle), control, motion planning, path planning and cooperative robots. Extensive knowledge of **ROS**/**ROS2**. Robot Simulation (**Gazebo**). Computer vision for robotics using (**OpenCV**), pattern recognition. Deep learning and deep reinforcement learning for robotics (**TensorFlow**/**Open AI Gym**).
Teaching Assistant	**Mobile Robotics** (2018) & **Introduction to Artificial Intelligence** (2021) both at UFMG.

Selected Media Appearances

- By Wevolver, 2022. Article: "**HeRo 2.0, an ultra-low cost 3D-printed robotics platform, could open swarm robotics experimentation up to all**". Language: English. Link: https://www.wevolver.com/article/hero-20-an-ultra-low-cost-3d-printed-robotics-platform-could-open-swarm-robotics-experimentation-up-to-all

- By G1/Globo newspaper, 2019. Article: "**UFMG researchers participate in autonomous drone competition (Pesquisadores da UFMG participam de competição com drones sem piloto)**". Language: Portuguese. Link: https://g1.globo.com/mg/minas-gerais/noticia/2019/07/04/pesquisadores-da-ufmg-participam-de-competicao-com-drones-sem-piloto.ghtml

- By O Tempo newspaper, 2019. Article: "**UFMG Team is finalist at an AI competition in the USA (Equipe da UFMG é finalista em competição de inteligência artificial nos EUA)**". Language: Portuguese. Link: https://www.otempo.com.br/interessa/equipe-daufmg-e-finalista-em-competicao-de-inteligencia-artificial-nos-eua-1.2201181

Scientific Production

Journal: 7 + 1 (accepted, and under review)
Conference: 12
Workshop/Abstracts: 4

Selected publications:

- **Rezeck, P.** and Chaimowicz, L. (2022). **Chemistry-Inspired Pattern Formation with Robotic Swarms**. In 2022 IEEE Robotics & Automation Letters and IEEE/RSJ International Conference on Intelligent Robots and Systems (RAL/IROS) (pp. 9131-9138). IEEE.

- **Rezeck, P.**, Azpurua, H., Correa, M. F., and Chaimowicz, L. (2022). **HeRo 2.0: A Low-Cost Robot for Swarm Robotics Research (pre print)**. In 2022 Autonomous Robots Journal (AURO).

- **Rezeck, P.**, Assunção, R. M., and Chaimowicz, L. (2021, September). **Cooperative Object Transportation using Gibbs Random Fields**. In 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (pp. 9131-9138). IEEE.

- **Rezeck, P.**, Assunção, R. M., and Chaimowicz, L. (2021, May). **Flocking-segregative swarming behaviors using Gibbs random fields**. In 2021 IEEE International Conference on Robotics and Automation (ICRA) (pp. 8757-8763). IEEE.

Journal Publications:

- (J1) **Rezeck, P.** and Chaimowicz, L. (2022). **Chemistry-Inspired Pattern Formation with Robotic Swarms**. In 2022 IEEE Robotics & Automation Letters and IEEE/RSJ International Conference on Intelligent Robots and Systems (RAL/IROS) (pp. 9131-9138). IEEE.

- (J2) **Rezeck, P.**, Azpurua, H., Correa, M. F., and Chaimowicz, L. (2022). **HeRo 2.0: A Low-Cost Robot for Swarm Robotics Research (pre print)**. In 2022 Autonomous Robots Journal (AURO).

- (J3) Rezende, A., Miranda, V. R., **Rezeck, P. A.**, Azpúrua, H., Santos, E. R., Gonçalves, V. M., ... & Freitas, G. M. (2021). **An integrated solution for an autonomous drone racing in indoor environments**. Intelligent Service Robotics, 14(5), 641-661.

- (J4) Pires, A. G., **Rezeck, P. A.**, Chaves, R. A., Macharet, D. G., & Chaimowicz, L. (2021). **Cooperative Localization and Mapping with Robotic Swarms**. Journal of Intelligent & Robotic Systems, 102(2), 1-23.

- (J5) Santos, V. G., Pires, A. G., Alitappeh, R. J., **Rezeck, P. A.**, Pimenta, L. C., Macharet, D. G., & Chaimowicz, L. (2020). **Spatial segregative behaviors in robotic swarms using differential potentials**. Swarm Intelligence, 14(4), 259-284.

- (J6) Santos, E. R., Azpurua, H., **Rezeck, P. A.**, Corrêa, M. F., Vieira, M. A., Freitas, G. M., & Macharet, D. G. (2020). **Localization using ultra wideband and IEEE 802.15. 4 radios with nonlinear bayesian filters: a comparative study**. Journal of Intelligent & Robotic Systems, 99(3), 571-587.

- (J7) Azpúrua, H., Potje, G. A., **Rezeck, P. A.**, Freitas, G. M., Uzeda Garcia, L. G., Nascimento, E. R., ... & Campos, M. F. (2019). **Cooperative digital magnetic-elevation maps by small autonomous aerial robots**. Journal of Field Robotics, 36(8), 1378-1398.

- (J8) Macharet, D. G., Perez-Imaz, H. I., **Rezeck, P. A.**, Potje, G. A., Benyosef, L. C., Wiermann, A., ... & Campos, M. F. (2016). **Autonomous aeromagnetic surveys using a fluxgate magnetometer**. Sensors, 16(12), 2169.

Conference Publications:

- (C1) **Rezeck, P.**, Assunção, R. M., and Chaimowicz, L. (2021, September). **Cooperative Object Transportation using Gibbs Random Fields**. In 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (pp. 9131-9138). IEEE.

• (C2) **Rezeck, P.**, Assunção, R. M., and Chaimowicz, L. (2021, May). **Flocking-segregative swarming behaviors using Gibbs random fields**. In 2021 IEEE International Conference on Robotics and Automation (ICRA) (pp. 8757-8763). IEEE.

• (C3) Carvalho, L., **Rezeck, P.**, Lima, M. V., Pinto, L., Freitas, G., Nascimento, E. R., ... & Campos, M. F. (2020, August). **On the evaluation of force feedback augmented teleoperation of excavator-like mobile manipulators**. In 2020 IEEE 16th International Conference on Automation Science and Engineering (CASE) (pp. 1401-1407). IEEE.

• (C4) Chaves, R., **Rezeck, P.**, & Chaimowicz, L. (2019, December). **SwarMap: Occupancy grid mapping with a robotic swarm**. In 2019 19th International Conference on Advanced Robotics (ICAR) (pp. 727-732). IEEE.

• (C5) de Lima, M. V., Cid, A., Cadar, F., Pinto, L., **Rezeck, P.**, Grabe, T., ... & Campos, M. F. **Realimentaçao de Força para Teleoperaçao de Escavadeiras**. In 2019 14th Simpósio Brasileiro de Automação Inteligente (SBAI).

• (C6) E. R. S. Santos, H. Azpurua, **P. A. F. Rezeck**, M. F. S. Corrêa, G. M. Freitas and D. G. Macharet, **Global Localization of Mobile Robots Using Local Position Estimation in a Geo Tagged Wireless Node Sensor Network**, 2018 Latin American Robotic Symposium, 2018 Brazilian Symposium on Robotics (SBR) and 2018 Workshop on Robotics in Education (WRE), 2018, pp. 39-44, doi: 10.1109/LARS/SBR/WRE.2018.00017.

• (C7) **Rezeck, P.**, Frade, B., Soares, J., Pinto, L., Cadar, F., Azpurua, H., ... & Campos, M. F. (2018, November). **Framework for haptic teleoperation of a remote robotic arm device**. In 2018 Latin American Robotic Symposium, 2018 Brazilian Symposium on Robotics (SBR) and 2018 Workshop on Robotics in Education (WRE) (pp. 170-175). IEEE.

• (C8) **Rezeck, P.**, Cadar, F., Soares, J., Frade, B., Pinto, L., Azpurua, H., ... & Campos, M. F. M. (2018, November). **An immersion enhancing robotic head-like device for teleoperation**. In 2018 Latin American Robotic Symposium, 2018 Brazilian Symposium on Robotics (SBR) and 2018 Workshop on Robotics in Education (WRE) (pp. 164-169). IEEE.

• (C9) **Rezeck, P. A.**, Azpurua, H., & Chaimowicz, L. (2017, November). **HeRo: An open platform for robotics research and education**. In 2017 Latin American Robotics Symposium (LARS) and 2017 Brazilian Symposium on Robotics (SBR) (pp. 1-6). IEEE.

• (C10) Edwards, V., **Rezeck, P.**, Chaimowicz, L., & Hsieh, M. A. (2016, October). **Segregation of heterogeneous robotics swarms via convex optimization**. In Dynamic Systems and Control Conference (Vol. 50695, p. V001T03A001). American Society of Mechanical Engineers.

• (C11) Perez-Imaz, H. I., **Rezeck, P. A.**, Macharet, D. G., & Campos, M. F. (2016, August). **Multi-robot 3D coverage path planning for first responders teams**. In 2016 IEEE International Conference on Automation Science and Engineering (CASE) (pp. 1374-1379). IEEE.

• (C12) **Rezeck, P. A.**, Vieira, M. A., Chaimowicz, L., & Campos, M. F. (2013, October). **On the development of a robotic system for telepresence**. In 2013 Latin American Robotics Symposium and Competition (pp. 8-13). IEEE.

Abstracts, Posters and Workshops:

• (W1) **Paulo Rezeck**, Héctor Azpúrua, Mauricio Ferrari & Luiz Chaimowics. "**HeRo: An Open Robot Platform for Swarm Robotics Research**". Robot Swarms in the Real World From Design to Deployment (Workshop at ICRA 2021), 2021, Xi'an - China.

• (W2) Azpurua, H. **Rezeck, P.**, Torre, M., Zanetti, E. Freitas, G., Garcia, L., Nascimento, E. R., Macharet, Douglas G., Campos, M. F. M. "**Detection Of Uncrushables In Ore Piles Using Small And Autonomous Aerial Robots**". In: Mines Of The Future 2018, 2018, Aachen. Aims 2018,

• (W3) **Rezeck, P.**, Azpurua, H., Chaimowicz, L. "**Hero: An Open Platform For Robotics Research And Education**". In: IEEE/RSJ International Conference On Intelligent Robots And Systems (IROS), 2017.

• (W4) Azpurua, H. Potje, G., **Rezeck, P.**, Macharet, D. G., Freitas, G., Garcia, L., Campos, M. F. M. "**Towards a Cooperative Method For 3D Magnetic Maps Generation Using Small And Autonomous Aerial Robots**". In: IEEE/RSJ International Conference On Intelligent Robots And Systems (IROS), 2017.