Thomas **Stastny**

Aerial-Roboticist / GNC Engineer

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Summary

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8+ years aerial-robotics research experience in aerodynamic modeling, simulation, system identification, state estimation, control, planning, and flight-testing of fixed-wing, multi-copter, and hybrid vertical take-off and landing (VTOL) unmanned aerial vehicles (UAVs).

Grants: Authorship of **successful** research proposals with funding totaling >**1.7M USD**.

Publications: As of March 11, 2021, peer-reviewed publication count: **31**, h-index: **12**, citation count: **548** (source: Google Scholar).

Mentorship: Supervision of **4** Ph.D. students and **50+** M.Sc. and B.Sc. theses, resulting in (to date) **12** peer-reviewed publications.

Field experience: Organization/contributions of/to aerial-robotic field-campaigns in the Arctic, Antarctic, Brazilian Amazon, and Swiss/Italian Alps.

Education

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2014 - 2020 **ETH Zürich**, Zürich, Switzerland
Ph.D. in Robotics, supervised by Prof. Roland Siegwart in the *Autonomous Systems Lab*
Dissertation: *Low-Altitude Control and Local Re-Planning Strategies for Small Fixed-wing UAVs*

2012 - 2014 **University of Kansas**, Lawrence, KS, USA
M.Sc. in Aerospace Engineering *(with Honors)*, GPA: 4.0/4.0

2012 **TU Delft**, Delft, Netherlands
Coursework in Systems & Control and Aerospace Engr. M.Sc. Programs

2008 - 2012 **University of Kansas**, Lawrence, KS, USA
B.Sc. in Aerospace Engineering, GPA: 3.7/4.0

Research Experience

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Since 10/2020 **Autonomous Systems Lab (ASL), ETH Zürich** – Post-Doctoral Researcher

- Supervise and coordinate PhD and Masters student research activities related to fixed-wing UAVs, recent results including:
  - automatic tilt-wing UAV control, stabilized deep stalled flight, span/chord-wise wing-fitted pressure sensor arrays for in-flight airflow measurement, design and wind tunnel characterization of a winged omni-directional UAV
- Project lead for on-going funded projects:
  - high-speed vision-based payload recovery using fixed-wing UAVs
  - precision sensor placement and recovery on remote glaciers using a long-range tilt-wing UAV
  - "AvalMapper", developing an autonomous aerial detection and mapping system for high-alpine avalanches utilizing machine learned classification methods and informative path planning for reliably reconstructable snow-depth maps

2014 - 2020 **Autonomous Systems Lab (ASL), ETH Zürich** – PhD Research Assistant

- Core researcher on EU search-and-rescue robotics projects *SHERPA* and *ICARUS*, organizing multiple university and industry partners in collaborative multi-robotic field demonstrations.
- Interfaced with customers and industry partners within the ESA precision-farming project *SOLAR3* to deliver a reliable automatic, multi-hour endurance, solar-powered surveying drone solution to non-expert end-users in Switzerland and Ukraine.
- Developed and deployed:
  - robust, wind-aware estimation, guidance, and control algorithms for UAVs in extreme wind conditions
  - nonlinear model predictive control (NMPC) schemes for fixed-wing UAVs including objectives for aggressive 3D path following, actuator fault tolerance, stall prevention, and vision-based terrain feedback
  - a semi-automated system identification pipeline for fixed-wing UAVs (iterated EKF, nonlinear parameter optimization)
- Conducted performance optimization and developed automatic take-off, landing, and cruise control design for the *AtlantikSolar UAV*, resulting in an **81.5 hour endurance world record** solar-powered flight for aircraft <50kg https://youtu.be/8m4_NpTQn0E and 26 hour, fully autonomous, search-and-rescue payload equipped flight https://youtu.be/8m76Mx9m2nM

2012 - 2014 **Center for Remote Sensing of Ice Sheets (CReSIS), University of Kansas** – Masters Research Assistant

- Conducted research on control and planning for fixed-wing UAVs including multi-agent avoidance and formation strategies.
- Contributed to the design, integration, and **Antarctic deployment** of a polar-conditioned fixed-wing UAV with integrated dual-frequency ground-penetrating radar.

Programming C/C++, Python (NumPy, SciPy), Matlab/Simulink ● **Software** Linux, Robotic Operating System (ROS), Embedded Systems, Git, CI, Unigraphics NX (CAD) ● **Hardware** 3D Prototyping, Radio controlled (RC) piloting of small fixed-wing aircraft and multi-copters

Field Projects

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- **Supervised/Managed** student/engineering work on platform and payload development towards autonomous, beyond visual line-of-sight (BVLOS), drone-based deployment of GNSS monitoring stations on the **Gorner Glacier**, Switzerland. (2019) video: https://youtu.be/1tvYj1aGEUc
- Contributed regulatory documentation and flight-stack verification for the *first* networked (via industry partners Swisscom, INVOLI, and v2sky), BVLOS flight in Switzerland over Lake Neuchâtel. (2019) video: https://youtu.be/ks-TiJP3dxs
- **Organized/Lead** UAV operations in **Northwest Greenland** for a glacier monitoring field campaign, resulting in *first-ever* autonomous, BVLOS, solar-powered flights of a UAV in a polar region. (2017) website: http://sun2ice.ethz.ch, video: https://youtu.be/wyS6W1t_ryQ
- **Organized/Lead** field operations together with Swissnex Brazil and Brazilian Civil Aviation Authorities resulting in *first-ever* solar-powered flights of a UAV over the **Amazon rainforest** and the aerial monitoring/mapping of an oil spill on the Rio Pará.
- **8-week deployment** as mission planner and ground station operator for autonomous, BVLOS flights of a radar-integrated UAV in **Antarctica**, resulting in *first-ever* glacial bed-rock sounding via a UAV. (2014) https://cresis.ku.edu/content/research/field-programs/antarctica#2013

(Selected) Publications

A full list of publications may be found https://scholar.google.ch/citations?user=R5Fs1A4AAAAJ&hl=en, or is available upon request.

Optimization-Based Control:

- **T. Stastny** and R. Siegwart. "Nonlinear Model Predictive Guidance for Fixed-wing UAVs Using Identified Control Augmented Dynamics". *In: International Conference on Unmanned Aircraft Systems (ICUAS)*. (2018).
- S. Verling, **T. Stastny**, G. Bättig, K. Alexis, and R. Siegwart. "Model-based Transition Optimization for a VTOL Tailsitter". *In: IEEE International Conference on Robotics and Automation (ICRA)*. (2017).

VTOL, Hybrid Platform Identification and Control:

- D. Rohr, **T. Stastny**, S. Verling, and R. Siegwart. "Attitude and Cruise Control of a VTOL Tiltwing UAV". *In: IEEE Robotics and Automation Letters*. (2019). https://youtu.be/pSXEnHUY2_4
- C. Olsson, S. Verling, **T. Stastny**, and R. Siegwart. "Full Envelope System Identification of a VTOL Tailsitter UAV". *In: AIAA Guidance, Navigation, and Control (GNC) Conference*. (2021).
- S. Fuhrer, S. Verling, **T. Stastny**, and R. Siegwart. "Fault-tolerant Flight Control of a VTOL Tailsitter UAV". *In: IEEE International Conference on Robotics and Automation (ICRA)*. (2019).

Disturbance Modeling and Rejection:

- **T. Stastny** and R. Siegwart. "On Flying Backwards: Preventing Run-away of Small, Low-speed, Fixed-wing UAVs in Strong Winds". *In: IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. (2019). https://youtu.be/oM690LO29kM
- D. Hentzen, **T. Stastny**, R. Siegwart, and R. Brockers. "Disturbance Estimation and Rejection for High-Precision Multirotor Position Control". *In: IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. (2019). https://youtu.be/-1PvZ5YBIuw
- Y. Demitri, S. Verling, **T. Stastny**, A. Melzer, and R. Siegwart. "Model-based Wind Estimation for a Hovering VTOL Tailsitter UAV". *In: IEEE International Conference on Robotics and Automation (ICRA)*. (2017).

Long-term Flight Autonomy:

- P. Oettershagen, **T. Stastny**, T. Hinzmann, K. Rudin, T. Mantel, A. Melzer, B. Wawrzacz, G. Hitz, and R. Siegwart. "Robotic Technologies for Solar-powered UAVs: Fully Autonomous Updraft-aware Aerial Sensing for Multiday Search-and-rescue Missions". *In: Journal of Field Robotics (JFR)*. (2018). https://youtu.be/8m76Mx9m2nM

Mentorship & Teaching

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- **Supervised 4** PhD Students (ongoing), **24** Masters Theses, **18** Masters Semester Theses, and **14** Bachelor Theses at ETH Zürich. (2014 – Present)
- **Coached 3** ETH Zürich Focus Projects – teams of 8-12 B.Sc. students who develop a robotic product from A to Z:
  - *Dipper* – a flying, diving, swimming, and re-emerging, swept-wing UAV. video: https://youtu.be/q_9tSHTW1xE
  - *ftero* – a VTOL UAV for airborne wind energy (year 1 and 2)
  - *VertiGo* – a wall-riding robot. Resulted in a patent. video: https://youtu.be/KRYT2kYbgo4
- **Co-Lecturer** for *ETH Zürich* M.Sc. course "Robot Dynamics" (2015-Present).
- **Guest Lecturer** for *University of Kansas* Aerospace M.Sc. course "Optimal Control" (2013).
- **Teaching Assistant** for *University of Kansas* B.Sc. courses "Introductory Topics in Mathematics" and "Elementary Statistics". (2010 – 2012)

Awards

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- **O. Hugo Schuck Best Paper Award** (2018) for American Control Conference (ACC) paper: *"Gone with the wind: Nonlinear Guidance for Small Fixed-wing Aircraft in Arbitrarily Strong Windfields"*. http://a2c2.org/awards/o-hugo-schuck-best-paper-award
- **United States Department of Defense Antarctica Service Medal** (2014)
- **University of Kansas Aerospace Undergraduate Researcher Award** (2012)