Vlad Niculescu

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Google scholar

Nationality: **Romanian (Residence permit B)**
Date of Birth: **16/07/1994**

Education

01/2020 – present **ETH Zürich**
Pursuing a PhD in Electrical Engineering under the supervision of Prof. Dr. Luca Benini in the Integrated Systems Laboratory and the PULP Platform. My research focuses on developing autonomous solutions that enable localization, perception, and mapping, exploiting low-power computing platforms. The algorithms target resource-constrained, centimeter-size robots, such as nano-UAVs.

10/2017 – 07/2019 **ETH Zürich**
Obtained a MSc in Robotics, Systems and Control. Major subjects: Control Systems, Machine Learning.

10/2013 – 07/2017 **Politehnica University of Bucharest**
Obtained a BSc in Electronics and Telecommunications. Graduated in top 1% in my faculty.
Major subjects: Theory of Circuits, Programming Languages, Signal Processing, Microcontrollers

Work Experience

07/2018 – 08/2019 **Electrical Lead at Swissloop**
I led the electrical team of Swissloop, a student project within ETH Zürich which developed a self propelled vehicle that reached 252 km/h in a mile-long vacuum tube at SpaceX Hyperloop Competition.

07/2017 - 09/2017 **Google Summer of Code**
I worked with Apertus and developed a smart switching regulator for the AXIOM camera system. I have designed the circuit board and developed the HDL code of the regulator's control system algorithm.

07/2015 - 05/2017 **Embedded Applications Intern at Microchip Technology – Mixed Signal Team**
I worked in the mixed signal team as a firmware developed for data acquisition systems working with 32-bit microcontrollers. In addition, I designed circuit boards for the acquisition systems.

Teaching

03/2021 - 06/2023 **Embedded Systems with Drones at ETH Zürich**
Together with T. Polonelli, we set the foundation of a new course (theory slides and lab exercises) that teaches how the drones work, and the main algorithms for state estimation and flight control.

09/2016 - 05/2017 **Digital Electronics and Electronic Measurements at Politehnica University of Bucharest**
I taught laboratory classes for faculty of Automatic Control and Computer Science.

Awards

2nd place – SpaceX Hyperloop Pod Competition 2019.
1st place at Microsoft Imagine Cup National Phase. Quarter finalist in the World Phase - Seattle 2017
Top 10 in MakeMIT 2017 hackathon, MIT – Boston 2017
1st place at International Robotics Contest "Robochallenge", Bucharest 2015

Main Publications as First Author

NanoSLAM: Enabling Fully Onboard SLAM for Tiny Robots, in *IEEE Internet of Things Journal* 2024

Energy-efficient, Precise UWB-based 3-D Localization of Sensor Nodes with a Nano-UAV, in *IEEE Internet of Things Journal* 2022

Improving Autonomous Nano-Drones Performance via Automated End-to-End Optimization and Deployment of DNNs, in *IEEE Journal on Emerging and Selected Topics in Circuits and Systems* 2021

Fly, Wake-up, Find:UAV-based Energy-efficient Localization for Distributed Sensor Nodes, in *SUSCOM*

Towards a Multi-Pixel Time-of-Flight Indoor Navigation System for Nano-Drone Applications, in IEEE *International Instrumentation and Measurement Technology Conference (I2MTC)* 2022

Automated Tuning of End-to-end Neural Flight Controllers for Autonomous Nano-drones, in IEEE *International Conference on Artificial Intelligence Circuits and Systems (AICAS)* 2021

Skills

Topics SLAM, Distributed Mapping, Vision-based Perception, Localization, State Estimation, Deep Learning, Autonomous Robots, Embedded Systems, Analog Circuit Design, PCB Design

Languages Romanian: mother tongue. English: fluent. Spanish: basic

Notable Projects

Onboard SLAM for Tiny Robots

So far, SLAM was only feasible onboard robotic platforms that host power-hungry computing platforms, due to the required computational load and memory demands. Our work introduces NanoSLAM, a lightweight and optimized end-to-end SLAM engine specifically designed to operate on centimeter-size robots at a power budget of less than 100 mW. NanoSLAM is a graph-based approach that employs ICP scan-matching every time loop-closure is performed. The algorithm is developed in C, and can run either on single core or leverage the parallel capabilities of multicore RISC-V-based SoCs. In addition, we propose a fully distributed version of NanoSLAM which enables a swarm of tiny robots to perform collaborative mapping of an environment, relying on the UWB technology for communication and range-based collision avoidance. Video here.

Vision-based Navigation for Nano-drones

This work enables vision-based autonomous navigation onboard a 30 g drone, exploiting a lightweight CNN that works with greyscale images provided by the onboard camera. To achieve energy efficiency and decrease the inference latency, the deep-learning model is quantized to 8-bit, with negligible accuracy loss with respect to the full precision model. This work explores methodologies and software tools to streamline and automate all the model deployment on a ULP multicore system-on-chip. Our navigation system can navigate both indoors and outdoors, follow corridors, steer in narrow pipes, and avoid static and dynamic obstacles when moving with a speed of up to 2 m/s. Video here.

UWB-based Sensor Node Localization

Smart interaction between autonomous centimeter-scale drones and IoT sensor nodes is an upcoming high-impact scenario. This work tackles precise 3D localization of unknown position edge nodes with an autonomous drone that weighs 30 g. We employ a multilateration algorithm that runs onboard the drone and estimates the positions of the nodes relying on distance measurements acquired with UWB. However, UWB distance measurements are affected by multiple sources of errors, such as uneven radiation pattern of the antenna. We therefore propose a lightweight machine learning algorithm that models the UWB errors and allows to mitigate their effect. In addition, we propose a method to automatically train the model parameters onboard the drone. Video here.