Michael Mugnai's Curriculum Vitæ

Personal Data

Full name:	Michael Mugnai
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Education

Current Oct. 2020	PhD in Emerging Digital Technology, Scuola Superiore Sant'Anna Curriculum: Perceptual Robotics Research proposal: Intelligent Unmanned Vehicles
Aug. 2022	2022 IEEE RAS Summer School on Multi-Robot Systems → Website
Sept. 2020 Oct. 2016	Master's Degree in Robotics and Automation Engineering Ingegneria Robotica e dell'Automazione, Università di Pisa Thesis: "Towards autonomous racing of FSAE vehicles via MPC" → Abstract Advisor: Prof. Marco Gabiccini Final grade: 110/110 cum Laude
July 2019 June 2019	Master course in Autonomous Driving, funded by FCA Experis Academy, Bergamo, Italy
Oct. 2016 Oct. 2012	Bachelor's Degree in Mechanical Engineering Electrical-Automation Specialization, Università degli studi di Firenze Thesis: "Pointclouds for 3D models reconstruction" Advisor: Monica Carfagni
July 2012 -	IT Expert, Istituto Tecnico Commerciale "A. Volta", Florence Final Grade: 100/100

Experience

Current Mar. 2021	Tutoring on class projects and theses – University of Pisa holds Master's degree on Robotics and Automation Engineering and Mechatronics and Vision class, where several students approach hardware projects that spans from the low-level actuation controls, up to autonomous navigation and control of both ground and aerial vehicles. I propose related topics and follow master students through their work.
Oct. 2021 Nov. 2018	Formula SAE – Driverless Sector Manager @ University of Pisa Racing Team. A combustion racing car is developed from scratch, in order to compete in autonomous competition between universities. My contribute mainly was on developing low-level actuation, perceptual systems and high-level trajectory planning, beyond managing the work of the group of students of the Driverless Sector.
June 2020 Oct. 2016	Many projects for my Master course exams. → Detailed list of projects

Publications

Towards Autonomous Firefighting UAVs: Online Planners for Obstacle Avoidance and Payload Delivery

Journal of Intelligent & Robotic Systems (JINT) DOI: 10.1007/s10846-023-02042-7

An Efficient Framework for Autonomous UAV Missions in Partially-Unknown GNSS-Denied Environments

MDPI Drones 2023, Vol. 7 - Special Issue on Navigation, Control and Mission Planning Advances for Safe, Efficient and Autonomous Drones DOI: 10.3390/drones7070471

KerubLess: Design of a Driverless Formula SAE Vehicle

2022 International Conference on Industrial Cyber-Physical Systems (ICPS) DOI: 10.1109/ICPS51978.2022.9816876

An Object-Oriented Exploration Algorithm for Unmanned Aerial Vehicles

2021 International Conference on Unmanned Aircraft Systems (ICUAS) DOI: 10.1109/ICUAS51884.2021.9476764

Master Thesis

Towards autonomous racing of FSAE vehicles via Model Predictive Control

2020 Master's Degree on Robotics and Automation Engineering

Abstract: In order to design an high-level control for the autonomous vehicle of the University of Pisa Racing Team and compete in Formula SAE (FSAE) races, a Nonlinear Model Predictive Control (MPC) is proposed, lightweight enough to be computed online on embedded systems, but at the same time composed by a vehicle model sufficiently descriptive to be effective even on simulators with far more complex vehicle models and the real vehicle. Track identification from a set of sampled data (right and left margins) is encoded in splines, while the optimal control problem is written on track reference system, in the space domain. The proposed control is able to achieve minimum traversal time of the considered receding horizon, inherently obtaining both optimal trajectory and references (acceleration, brake and steer angle) for the lower control loops in few milliseconds.

Achievements

Leonardo Drone Contest 2023: cooperative navigation and mapping of unknown indoor environments, between a ground vehicle, a quadrotor and a pan-tilt-zoom camera. 1st position out of 7 Italian Universities.
My contribute involved in the deployment of the navigation system for both the ground and aerial vehicles, with a shared map that expands while exploring, and an obstacle avoidance module.

ICUAS 2022 UAV Competition: minimum-time trajectory tasks for obstacle avoidance and payload delivery in cluttered environments. Top-5 (out of 48 participants) in the simulation phase, 3rd position on finals (among top-5 teams of the previous phase) on real scenarios at Dubrovnik, during ICUAS22 Conference. → Website
My contribute focused on optimal planning for the payload delivery: a ball, attached below the multicopter through magnets, is the payload that has to be delivered over detected landmarks. An optimal trajectory planner is proposed, which minimises traversal time and achieve precise ballistic launches with safe trajectories. → Publication

Leonardo Drone Contest 2022: exploration in GPS-denied environment with a vision-based, self developed quadrotor. Localisation and tracking of unknown agents was the main part of the challenge, jointly with mission handling and online trajectory replanning. 3rd position out of 6 Italian Universities. → Competition video
My contribute involved in the deployment of the visual-inertial localisation system, low-level control of the quadrotor dynamics and the development of the global planner in which the entire navigation and guidance stack is based. → Publication

Languages

English:	Fluent
Italian:	Mother-tongue

Certificates

APR Pilot certificate - non-critical operations	DAC (LUX-RP-19931121nud1)
APR Pilot STS scenarios	IT-STS01 IT-STS02 (ZEF-RP-026-2023)
Mechanical Design certificate (Level: Associate)	SOLIDWORKS (Code C-2Z375HQXWJ)

Skills

Programming Knowledge (Adv.):	C, C++, Python, ROS, ROS2, Matlab, Mathematica.
(Intermediate):	Rust, bash.
Embedded systems:	UP-Board, Lattepanda, Raspberry Pi, Intel boards, Nvidia boards, STM32, Atmel, Arduino.
Other technical skills:	git, Docker, Singularity, I2C, UART, CAN, CAN-Open, SOLIDWORKS, Blender, 3D printing.
Personal skills:	attention to detail, logical thinker, problem solving, professional manner, calmness under pressure.
Social skills:	keen to team-work, diplomacy, empathy.

Master's degree Projects

Real Time Systems	2D Tracking and Intercepting Ballistic System, an hard Real-Time simulator in C.
Aerospace Robotics	Preliminary planning for an Earth-Venus round-trip autonomous mission, simulation and optimization in Matlab.
Intelligent Systems	A Neural Network Classification System for Colour Differences, strengthen with Fuzzy Logic.
Underwater Robotics	Outlier Handling Techniques in Acoustic Signals for Marine Applications, a Matlab application to handle real sensor data.
Distributed Robotics	Formation Control for Unicycles in two approaches: Consensus Formation and Leader-Followers. Robust control lows developed in Matlab-Simulink, 2D simulation ambient realized in R.O.S.
Robot Control	Dynamics control of serial manipulator with several control laws, many of them adaptive. Control of a landing Rocket exploiting non-linearities of its model in order to achieve global asymptotical stability.
Control of Uncertain Systems	Classical and Robust Controls over an highly coupled MIMO plant: the Distillation Column. PIDs, Singular Value Decomposition, Direct Nyquist Array, LQG, H_∞ and μ are produced and their result compared.
Robot Mechanics	An Hexapod Robot, geometrically developed on Mathematica, hardware on SolidWorks, software in R.O.S. (C++ and Python). Simulated on Mathematica and Gazebo. Implemented with an Nvidia Jetson TX2.
Guidance and Navigation Systems	SLAM on the Hexapod Robot, that allows it to navigate on unknown indoor or outdoor territory, while mapping the environment. The algorithm uses Extended Kalman Filter to fuse data incoming from IMU, Visual and Command odometry in order to estimate robot current pose.

A more detailed view of all the above can be found on my LinkedIn profile.

Pisa, August 7, 2024

Best regards,
Michael Mugnai