Michael Mugnai's Curriculum Vitæ

Personal Data

Full name:	Michael Mugnai
ORC-ID:	0000-0001-7983-6780
Place and Date of Birth:	Florence | 21 November 1993
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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
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
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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

Achievements

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.

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.

Languages

English:	Fluent
Italian:	Mother-tongue

Certificates

APR Pilot certificate (non-critical operations)	**ENAC** (Code ITA-RP-0172ba2a41f4)
Mechanical Design certificate (Level: Associate)	**SOLIDWORKS** (Code C-2Z375HQXWJ)

Skills

Programming Knowledge (Adv.):	Python, C, C++, Java, R.O.S., Matlab, Mathematica.
(Intermediate):	Rust.
Embedded systems:	UP-Board, Lattepanda, Raspberry Pi, Nvidia boards, STM32, Atmel, Arduino.
Other technical skills:	I2C, UART, CAN, CAN-Open, git, Docker, Singularity, 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.

Publications

KerubLess - Design of a Driverless Formula SAE Vehicle

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

Abstract: This paper presents an overview of the *KerubLess*, the driverless vehicle of *E-Team Squadra Corse*. It contains design choices in terms of hardware components (i.e. sensors, actuators, control units) and software modules that define the driverless vehicle. It also gives an overview of the main tools and approaches used by the team to develop the entire design of the vehicle, transforming the 2019 combustion vehicle into a fully autonomous one. All design choices that led to the actual vehicle were subject to several constraints. A racing vehicle must be fast, so weight is a concern; moreover, sensors, actuators and control units must be small and fit on the 2019 vehicle, which was not developed considering any driverless extension; power-efficiency is also another critical issue since on-board power is limited; finally, team budget is also limited and choices keeping in mind a cost/performance trade-off must be made. The team won the Engineering Design Event at Formula SAE (Society of Automotive Engineers) Italy 2021.

An Efficient Object-Oriented Exploration Algorithm for Unmanned Aerial Vehicles

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

Abstract: Autonomous exploration of unknown environments usually focuses on maximizing the volumetric exploration of the surroundings. Object-oriented exploration, on the other hand, tries to minimize the time spent on the localization of some given objects of interest. While the former problem equally considers map growths in any free direction, the latter fosters exploration towards objects of interest partially seen and not yet accurately identified. The proposed work relates to a novel algorithm that focuses on an object-oriented exploration of unknown environments for aerial robots, able to generate volumetric representations of surroundings, semantically enhanced by labels for each object of interest. As a case study, this method is applied both in a simulated environment and in real-life experiments on a small aerial platform.

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.

Exam 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.

Best regards, *Michael Mugnai*