Curriculum vitae

PERSONAL INFORMATION

Lorenzo Vannini

JOB APPLIED FOR

Researcher

WORK EXPERIENCE

September 2022 – March 2023

Sant'Anna School of Advanced Studies Research Collaborator

Center ICT for Complex Industrial Systems and Processes (ICT-COISP) Scuola Superiore Sant'Anna- TeCIP Institute Via Moruzzi,1, 56124 Pisa, ITALY

I had the opportunity to work for Sant'Anna School of Advanced Studies with a CoCoCo contract (Coordinated and continuous collaboration contract). I have worked on an european research project called SMARTER (SteaM and gAs networks Revamping for the sTeElworks of the futuRe),which is cofunded by the European Union through the Research Fund for Coal and Steel. The project aimed at optimising the management and the structure of the steam and gas networks inside integrated steelworks for improving energy efficiency and reducing CO2 emissions as well as energy and management costs. In order to achieve such ambitious aim, our team has developed and implemented advanced control, optimization techniques and Machine Learning-based approaches. Our group has developed forecasting models of gas, steam and power production and demands for all the involved processes, furthermore we have analysed and modelled the entire system for more effective energy distribution and optimization of the processes.

October 2021–October 2022

Control group member Firenze Race team

Via di Santa Marta 50139 Firenze FI

Firenze Race Team is the official Formula SAE team of the "Università degli Studi di Firenze". Our team has the longest italian tradition in this kind of races. Every year the team designs and builds its Formula car and races with it all over the world, challenging the strongest teams worldwide. Recently the team is developing a full autonomous car (AV) capable of sensing its environment and operating without human involvement. The autonomous group is creating complex algorithms, machine learning systems, and powerful processors in order to create a full autonomous car. I am an active member of the controls group. The control group is developing a sophisticated control system for the autonomous vehicle. Our main goal is to develop mathematical models and algorithms in order to create a control strategy for the AV,using the state of the art of control theory (Model Predictive Control) and optimization techniques. We have controlled our nonlinear systems by using an adaptive MPC. AMPC controllers adjust their prediction model at run time to compensate for nonlinear or time-varying plant characteristics. All control strategy were created in the MATLAB Environment, this software is an ideal environment for developing and understanding our algorithms.

July 2022 – July 2022

Presentation of the Control Algorithms and models

Via di Santa Marta 50139 Firenze FI

In our work we have developed and implemented a mathematical model and a control strategy for the autonomous vehicle and at the end of the project we had to provide a technical documentation where we had to describe as precise as possible our work. I have then created a technical documentation using LATEX, where i have devised a comparative technical analysis between the algorithms and the mathematical models that we have used, describing every single choice made by the team, in order to ensure optimal performances.

June 2022 – July 2022

Tracking of an Aircraft using Kalman Filter

Via di Santa Marta 50139 Firenze FI

During our System Identification course we studied how to estimate the parameters of a nonlinear system by using dedicated algorithms such as Extended Kalman Filter, UKF, Particle Filter and Monte-Carlo based algorithms. In this project i had to estimate the position of a 2-D aircraft by using Nonlinear Filtering Theory. The exercise provided a matrix with the real position values of the airplane and the measurements made by a dedicated sensor. The main goal was to track the position of the airplane using only the provided measurements and compare the results with the real values. In the first instance i wrote a system of differential equations that could describe as precise as possible the estimating system,furthermore i transformed the SDE in a state space form so that it could be more conveniently used by a Nonlinear Filter. The extended Kalman filter arises by linearizing the state model about the current state estimate and using the linear Kalman filter to predict the next estimate,because i had an relatively good initial state estimation and the equation describing the system were continuously differentiable i decided to use an Extended Kalman Filter. I assumed that the random vector $\mathbf{w_k}$ that captures uncertainties in the model and measurement noise $\mathbf{v_k}$ are temporally uncorrelated (white noise), zero-mean random sequences with known covariances and both of them are uncorrelated with the initial state $\mathbf{x_0}$. Moreover i have initialized the process noise covariance matrix and the measurement noise covariance matrix. Finally i have plotted the results and compare the estimated values with the real ones.

June 2019 – June 2019

Python Project

Via di Santa Marta 50139 Firenze FI

During our "Laboratorio di tecnologia dell'informazione " (Information Technology laboratory) course we have acquired general Python skills. I developed a personal a small project, where i had to count the prime number less than a natural number n, this value is called $\pi(n)$, where $\pi(n)$ is the "prime counting function". "The prime number theorem" provides a way to approximate the number of primes less than or equal to a given number n, the theorem states that $\pi(n)$ is "asymptotically equal" to $\frac{n}{ln(n)}$. In my work i have created a small program where for any given natural number n it counts the number of prime less than n ($\pi(n)$) and compares the results with the asymptotic formula, clearly if $n \to \infty$ the difference between the two values tends to zero.

December 2019 – December 2019

Design of a MOSFET Amplifier

Via di Santa Marta 50139 Firenze FI

During our "Elettronica generale" course (Fundamental of Electronics) i have designed 3 Mosfet Amplifier using the 3 basic configurations: common-source, common-gate, and common-drain in the LTSPICE environment. Each of these configurations exhibit certain characteristics that make them more desirable in certain circuit applications than the others.

PUBLICATIONS AND ABSTRACTS SUBMISSIONS

September 2022 – March 2023

Abstract Submission for the 17th International Conference on Society and Materials, SAM17

Center ICT for Complex Industrial Systems and Processes (ICT-COISP) Scuola Superiore Sant'Anna- TeCIP Institute Via Moruzzi,1, 56124 Pisa, ITALY

For more than 16 years, SAM conferences have been an international forum for exchanging on new methodologies, new concepts and new issues that connect materials and society from different perspectives, ranging from social to engineering sciences. Our Team has submitted an abstract for the presentation of the project "Steam and gas networks revamping for the steelworks of the future," within the 17th edition of the Society and Materials Conference.

Article Title: "Smart revamping of gas and steam networks for the steelworks of the future",17th International Conference on Society and Materials, SAM17, May 9-10, 2023

EDUCATION AND TRAINING

October 2022-present

Master in Robotics and Automation (Current Average 28.3) Specialized in Artificial intelligence

University of Florence

Control Theory, Nonlinear Control theory, Nonlinear dynamical systems, Linear Optimization, Nonlinear optimization,Robotics, Machine learning, Deep learning, Reinforcement Learning, System identification,Robotics, Software engineering,Computer Vision.

October 2018-October 2021

Bachelor in Electrical engineering (Full marks cum laude)

University of Florence

Specialized in Control engineering, Artificial Intelligence, Robotics.

Thesis Title : "Design of reduced order L1 optimal controllers for unstable plants subject to delay" Supervisor : Alberto Tesi. The aim of my thesis was to analyze the problems relating to optimal controlling LTI systems (linear, time-invariant), causal, finite dimensional, characterized by an unstable plant $P(s)$. The main idea is to find, among all the stabilizing controllers,the one that minimizes the effect of an unknown disturbance $d(t)$ in the ouput $y(t)$. In this work i showed how the optimal controller $C^*(s)$,computed by mean of some Control theory's theorems and Optimization techniques, was not a feasible controller. Therefore i have approximated the theoretical optimal controller $C^*(s)$, with some physically realizable controllers using transformable Laplace functions which allowed me to obtain an easily implementable solution $C_{app}(s)$. Furthermore, i have plotted the Bode Diagram of the approximated controller $C_{app}(s)$ using MATLAB and analyze its characteristics, moreover i have studied how as the unstables poles $P(s)$ approaches its zeros, the system becomes extremely difficult to control.

PERSONAL SKILLS

Mother tongue: Italian

Other languages

UNDERSTANDING		SPEAKING		WRITING
Listening	Reading	Spoken interaction	Spoken production	
English	C1	C1	B2	C1	C1

Levels: A1 and A2: Basic user – B1 and B2: Independent user – C1 and C2: Proficient user
Common European Framework of Reference for Languages

Skills — Tools: C, C$_{++}$, $Python$, $Matlab$, $\LaTeX$, $HTML$

Driving licence: B

CERTIFICATIONS

April 2018

Cambridge Assessment English

English assessment level B2-C1

AWARDS

The Firenze Race Team has achieved the 1st place in the class 3 category at Formula SAE Italy 2022 which took place from 13th to 17th July in Varano de'Melegari. We have presented the project of an autonomus car with an internal combustion engine. As a member of the control group i have actively participated to the development of the project