

Alberto Petrucci

Embedded Linux Engineer & Ph.D. Candidate

I design mission-critical embedded software and research verifiable AI for space systems, connecting low-level Linux, avionics, hardware-software co-design and academic rigor.

Embedded Linux

Space software

Trustworthy AI

RISC-V / ARM / SPARC

Yocto & BSP

ECSS



CONTACT

petrucci.alberto@gmail.com

capriele.bitbucket.io

linkedin.com/in/alberto-petrucci

L'Aquila, Italy · Italian

01 PROFILE

I am an **Embedded Systems Engineer** and **Ph.D. Candidate** specializing in Trustworthy AI for Aerospace. My career is defined by a deliberate effort to bridge the gap between rigorous academic research and mission-critical industrial applications. Currently, I hold a dual role: designing avionics software at **Thales Alenia Space** and conducting doctoral research at the **Gran Sasso Science Institute (GSSI)**.

My academic background at the University of L'Aquila provided a strong foundation in Control and Automation Engineering, which I have since evolved into a specialized focus on **Hardware-Software Co-design** for space systems. Unlike traditional software engineering, my work confronts the strict Size, Weight, and Power (SWaP) constraints of orbiting platforms. I am dedicated to solving the "Edge-Computing Gap" in aerospace: enabling satellites to run complex, non-deterministic AI models safely onboard without relying on ground control.

My research contributions include the **Aerosafe framework**, which adapts ML safety assurance to ECSS standards, and the **SafeKAN architecture**, a hardware-accelerated approach using Kolmogorov-Arnold Networks for explainable anomaly detection. I am driven by the goal of enabling the next generation of **Multi-Satellite Systems** through distributed autonomy and verifiable on-board intelligence.

I am eager to bring this industrial insight and research rigor to the academic world, fostering a new generation of engineers who understand that a control algorithm is only as good as the hardware it flies on.

I plan to complete my Ph.D. by the end of August 2026.

02 EXPERIENCE**03/2024 - Present | L'Aquila, Italy****Embedded Linux Engineer**

Thales Alenia Space

Used Architectures

- RISC V
- Versal VCK190 / ARM A72 & ARM R5 (Multi-Core)

Used tools

- Yocto Project / BitBake
- Linux kernel build system
- Jenkins CI/CD
- GIT
- Eclipse / Visual Studio Code

Used languages, protocols and techniques

- C/C++ for kernel and user-space development
- Python for automation and testing
- Linux Kernel (I2C, SPI, UART, GPIO, DMA, LED subsystem, CAN, SpaceWire)
- Yocto recipes and layers for BSP customization
- U-Boot configuration and debugging
- Agile methodology
- RTOS: Real-Time Operating System (Linux Scheduler Patching)

As an Embedded Linux Engineer in the Space Systems division, I have been responsible for the design, customization, and integration of Linux-based solutions for on-board avionics and payload management systems. My role has required deep expertise in Linux kernel subsystems, device drivers, and build systems tailored for mission-critical hardware.

Main responsibilities and achievements:

- Developed and maintained custom Linux kernel drivers for satellite sensors and communication devices.
- Integrated and configured Yocto-based build systems for multiple target platforms, creating reproducible builds and tailored BSP layers.
- Worked on secure boot and U-Boot configurations, improving system reliability for space-grade embedded hardware.
- Implemented CI/CD pipelines (Jenkins + Git) to automate nightly builds, regression testing, and release processes.
- Performed debugging and optimization of low-level Linux subsystems to meet strict real-time and reliability constraints required for satellite missions.
- Collaborated with cross-functional teams (system, FPGA, and avionics engineers) to ensure hardware/software integration aligned with ESA standards.

This role has consolidated my expertise in **embedded Linux development for aerospace systems**, combining low-level driver programming, Yocto customization, and real-time system validation to ensure compliance with stringent space mission requirements.

02/2022 - Present | L'Aquila, Italy**System Software Responsible / Embedded Software Engineer**

Thales Alenia Space

Used Architectures

- Gaisler GR740 LEON4FT SPARC V8 (Multi-Core)

Used tools

- IBM Doors
- Eclipse
- Visual Studio Code
- GNAT Studio / GRMON / Codeo

Used languages, protocols and techniques

- Agile
- CI/CD
- C/C++

- Python
- Ada
- RTOS: Real-Time Operating System
- SpaceWire
- CAN
- Standard: ECSS-E-ST-40C

In my role as System Software Responsible and Embedded Software Engineer, I have contributed to several high-profile projects, each requiring a specialized skill set and comprehensive understanding of embedded systems and software development for space missions. Below is an overview of my key responsibilities and contributions:

PLATINO 1 / PLATINO 2

As an Embedded Software Engineer for the PLATINO missions, I was responsible for implementing new functionalities based on detailed requirements defined in the baseline. This involved close collaboration with the System team to evaluate and design solutions that effectively leveraged existing heritage while optimizing implementation efficiency. I was also tasked with managing spacecraft configuration, ensuring updates were accurately recorded in the project's DataBank to maintain traceability and alignment with system requirements.

Additionally, I developed detailed test procedures for verifying and validating the new functionalities, ensuring they adhered to mission requirements. Addressing Software Problem Reports (SPRs) was another critical aspect of my role, which involved replicating issues, identifying root causes, implementing fixes, and validating their resolution. To support the project's smooth execution, I also managed the development environment, ensuring a robust and stable platform for the team.

GALILEO 2nd Generation

In the GALILEO 2nd Generation project, I took on the role of System Software Responsible. My primary focus was to define the software requirements essential to meeting the system's overall objectives. This required a deep understanding of both the technical and operational needs of the mission. I worked to ensure that all requirements were correctly implemented, overseeing the development process to maintain alignment with the project goals.

Supervising the overall execution of the project was a key part of my responsibilities, which included monitoring progress, addressing risks, and ensuring quality standards were met at every stage. Additionally, I coordinated activities delegated to external companies, ensuring compliance with ESA (European Space Agency) regulations. This included oversight of the Independent Software Verification and Validation (ISVV) processes, a critical step in ensuring the software's reliability and safety for mission operations.

Iride NIMBUS Constellation

As the Data Handling Responsible for the Iride NIMBUS constellation, I managed the system documentation, focusing on the Avionic Software Requirements Baseline and the PUS (Packet Utilization Standard) Specification. These documents were foundational to ensuring that the software met the technical and operational standards required for the mission.

Beyond documentation, I played a key role in managing the system's data budget, which involved overseeing communication protocols and interfaces. Specifically, I managed data flow for CAN and SpaceWire buses, ensuring efficient and reliable data exchange across the system. Furthermore, I handled the satellite-ground communication budget for both X and S bands, ensuring optimal use of communication channels and maintaining alignment with mission constraints.

The NIMBUS platform has strong ties to research, having been developed in collaboration with the GSSI (GranSasso Science Institute). It will serve as the basis for the OASIS satellite and will be among the first micro-satellites used for scientific research on spatial particles.

Throughout my career in these projects, I have developed a strong expertise in embedded systems, software requirement management, and space mission operations, demonstrating a consistent ability to deliver high-quality results in challenging and innovative environments.



04/2020 - 02/2022 | L'Aquila, Italy

Embedded Linux Developer

Datalogic

Used tools

- Visual Studio Code
- Eclipse
- GIT + Agile
- Jenkins

Used languages, protocols and techniques

- C/C++
- I2C
- Linux kernel i2c_driver
- Linux kernel i2c_client
- DMA
- Linux kernel V4L2 (Video for Linux)
- Linux kernel led class (struct led_classdev)
- Yocto

I've managed a Linux yocto build system creating:

- recipes for different application and initialisation scripts
 - their sources were located on a git server
- recipes for different targets (debug/release on different boards)

Furthermore I've developed different I2C kernel drivers to manage:

- the camera sensor OV9282
- the camera sensor SC031GS
- the led driver LM3644
- different devices using a simple GPIO management

for the first two devices I've integrated the driver with V4L2 (Video For Linux) and I have created a custom system-class called "camera" in order to represent a common API interface to the high-level applications. I have also managed the linux kernel modules initialisation sequence because there were some sensors, like SC031GS and LM3644, whose drivers were strictly dependent each other.

All the frames captured with V4L were sent to an high-level application that was able to elaborate and manage them.

I've managed all the stuff to setup a Jenkins server to manage the nightly builds and the official releases for different platforms.

10/2018 - 04/2020 | Mirandola, Italy

Embedded Software Developer

Medtronic Bellico

Used tools

- MPLAB X
- Octave
- SVN
- GIT

Used languages, protocols and techniques

- C/C++, Python
- UART, SPI
- PIC, dsPIC, NIOS
- Kalman Filtering
- Non linear Control (Backstepping)

The project started with the realization of a test bench to verify the feasibility of a future product whose main scope is to generate a well-mixed P.D. fluid (a fluid used in peritoneal dialysis). In particular I've developed:

- a driver to control three different piston pumps
- a driver to control a gear pump
- a driver to read the data from a flow-meter and its filtering (with Kalman) to get correct estimation of the volume of used water and of the flow-rate

Furthermore I've updated the control algorithm to allow the correct following of the trajectory reference.

I have developed a Python framework that is able to encode and decode JSON messages in order to allow the communication between the application layer (GUI) and the hardware layer (pumps, electro-valves, sensors and so on). Furthermore this framework controls a dynamic GUI that actively respond to low-level messages.

09/2017 - 10/2018 | Venaria, Italy

Software Integration Engineer

Magneti Marelli

I've worked as a System Integrator for a year. The main scope of the project was to simplify the software-build step of an Android based InfoCluster (Infotainment + Cluster) system. During this period I've worked to automate the Android build step and I've written different system JNI (Java Native Interface). Thanks to the audio team I've added a driver that allows the platform (based on a QCOM S820A processor) to correctly communicate with a different peripheral. In particular thanks to the JNI we got a communication crossing all the android-layers: from the application layer (Java world) to the HAL layer (C/C++ world)



06/2018 - 12/2018 | L'Aquila, Italy

Embedded Software Developer

SPITECNO

Used tools

- Mbed Studio
- MbedOS
- ARMCC 6 Compiler
- GIT

Used languages, protocols and techniques

- C/C++, Python
- UART, SPI
- STM32F407VG
- Modbus

The project has been divided into three parts:

- Implementation of the TCP/IP stack and Modbus protocol
- Implementation of the basic firmware workflow supporting three different boards and pinout
- Implementation of the bootloader to manage a remote firmware update (OTA)

In particular for the first part I've implemented all the required Modbus function (0x01, 0x03, 0x05, 0x02, 0x04, 0x06, 0x0F, 0x10) to support the management of different "virtual" registers from a remote connection. I call the registers "virtual" because I've emulated an EEPROM in a FLASH according STM32 standards. For the second part, instead, I've managed the main FSM to support three different boards:

- A board with only DIGITAL INPUT pins
- A board with DIGITAL INPUT + DIGITAL OUTPUT pins
- A board with ANALOG INPUT + ANALOG OUTPUT pins

These boards have a different schematic and a different pinout so, the firmware has been developed to automatically manage these cases. Further more I've linked Modbus registers with the ones related to these (A/D-I/O) ports. Finally, for the third part I've developed an OTA update to allow remote firmware updates. This has been done splitting flash into different regions in which one is static (the bootloader) another one is for the executing firmware and the last one is for the firmware-update. In particular the firmware is provided with an algorithm that verify update integrity and origin (using SHA1 + public/private key pair)

I have developed a GUI, written in Python, that:

- manages all the steps needed to create a valid image which is encrypted in such a way that is correctly recognised by the board bootloader
- allows an user to upgrade the firmware via OTA

03/2017 - 07/2017 | L'Aquila, Italy

Embedded Software Developer

R13

Project: Smart Road Signs

Used languages, protocols and techniques

- C/C++
- ARM mbed
- Kalman Filtering
- UART, SPI, bootloader

With a spin-off (R13) linked to the University of L'Aquila I've developed a board based on a Cortex-M4 architecture that is connected with a lot of sensors like:

- a wireless module based on the ESP8266 (WT8266-S1)
- a radio module based on the RTX-MID-3V
- a GSM+GPRS module based on the SIM900
- a GPS module based on the SIRFStar V
- an SPI SD-Card module
- a Bluetooth module based on RN41

The main purpose of this project is to control a leds panel to report dangers on the highway. The wireless and the radio module are used only to allow an external operator to change the panel's configuration (even via smartphones). Instead the SD-Card is used to save all the configuration and the GPS logs. This is a research work proposed by SISAS: an established company in the field of road signs.

03/2017 - 06/2017 | L'Aquila, Italy

Software Developer

R13

Project: Road Signs Identifications

Used languages, protocols and techniques

- C/C++
- OpenCV
- Kalman Filtering
- Neural Networks

With a spin-off (R13) linked to the University of L'Aquila I've developed a system, based on the famous OpenCV, to track and to identify a road sign from a sequence of images. In particular we are able to track the blue and red signs and to identify a subset of them.

07/2015 - 08/2016 | L'Aquila, Italy

Web Developer

Project: IECON2016

Used languages, protocols and techniques

- PHP
- CakePHP
- AJAX
- PHPRedis
- ISPCConfig

Web interface development + Android and IOS client development. Principally I've developed all the technologies to automatically manage a conference: from the initial author submission to the first and the second (the last) revision by the reviewers and to conclude with the final submission and the real registration (with a payment) to the conference. An app. for mobile devices has been developed to allow the consultation of the daily schedule. Then, thanks to XMPP, a real-time chat has been added to the app.

01/2015 - 08/2015 | L'Aquila, Italy

Embedded Software Developer

Project: Chemical process control

Used languages, protocols and techniques

- Cortex-M4
- Uart, SPI, I2C
- PHP + CakePHP
- AJAX
- WebSocket

At the chemical labs of the University of L'Aquila I've developed the following parts of the main project:

- Firmware development for the FRDM-K64F board: a micro-controller based on Cortex-M4 architecture
- Web GUI development

The first point is related to:

- the development of the main drivers for interfacing with some peripheral like (ADC, DAC and so on)
- read the main datas and control an oven with a PWM

The second part, instead, is related to the development of a GUI that is useful to:

- configure the micro-controller
- read some informations from 2 ABB devices
- read the temperature from a thermocouple

03 EDUCATION & TRAINING

10/2022 - Present | L'Aquila, Italy

Gran Sasso Science Institute: Artificial Intelligence Ph.D.

22 July 2017 | L'Aquila, Italy

Master's degree cum laude and academic mention in "**Ingegneria Informatica e Automatica**"

10/2015 - 07/2017 | L'Aquila, Italy

University of L'Aquila: Control and Automation Engineering

24 July 2015 | L'Aquila, Italy

Bachelor degree cum laude in "**Ingegneria dell'Informazione**" obtained on

10/2012 - 07/2015 | L'Aquila, Italy

University of L'Aquila: Information Engineering

09/2007 - 07/2012 | L'Aquila, Italy

High school diploma obtained at the Liceo Scientifico "A. Bafile" P.N.I. (Piano Nazionale Informatica)

04 ENGINEERING & TECHNICAL SKILLS**ENGINEERING SKILLS**

- Basic Maths and Physics
- Linear Systems Analysis and Control
- NonLinear Systems Analysis and Control
- Estimation and Kalman Filtering Theory
- Digital Electronics and Embedded Systems
- Hybrid Systems
- Robust Control
- Time-Delay Systems
- Optimal Control and Optimization
- Robotics
- Signal Theory, Modulation Theory applied to Telecommunications
- Analog Electronics
- Digital Signal Processing, Audio and Image Processing
- Fundamentals of Electrical Science, Electrical Drives and Power Electronics

ENGINEERING PROJECTS

- Trajectory tracking applied to car obstacle avoidance
- Inverse pendulum
- Java implementation of a simple game: Tank War
- C++ implementation of a firmware for the TIVA board to make some music effect
- Digital PLL implementation in Matlab/C++
- Robust quadcopter control based on hybrid BackStepping technique
- Several projects related to the simulation and the control of a real system

CONTROL AND AUTOMATION SKILLS**Non-Linear Control Algorithm**

- Backstepping
- Sliding Mode
- SuperTwisting
- SAB-SMC (Static Adaptive Backstepping - Sliding Mode Control)
- DAB-SMC (Dynamic Adaptive Backstepping - Sliding Mode Control)

Linear Control Algorithm

- PID (Proportional Integral Derivative Controller)
- LQR (Linear Quadratic Regulator Controller)
- LQG (Linear Quadratic Gaussian Controller: LQR + Kalman)

Filtering Algorithm

- Linear Kalman Filter
- EKF (Extended Kalman Filter)
- QKF (Quadratic Kalman Filter)
- UKF (Unscented Kalman Filter)

Observer Algorithm

- Linear Observer (Luenberger)
- Non Linear Observer (Luenberger-Like, Germani)
- Sliding Mode Observer
- Kalman based Observer

05 LANGUAGES

Mother Tongue: Italian
English

Listening	Reading	Spoken production	Spoken interaction	Writing
B2	B2	B2	B2	B2

06 HONOURS & AWARDS

Project Euler 254

One of the few to solve the problem proposed (statistically resolved by 0.20% of the participants) ↗ ↗

Codeflows 2019

Winner of the first round of the contest (top 200 of over >5000 participants)

January 2016 - January 2018

Winner of one of the four scholarships for Master Degree students provided by Istituto Nazionale di Fisica Nucleare (INFN) - Gran Sasso Science Institute (GSSI) branch, with merit

07 PUBLICATIONS & PATENTS

12-19 April 2026

Article:

Deploying SafeKAN for Anomaly Detection in Safety-Critical Satellite Operations: An Industry-Guided Study

Published at: International Conference on Software Engineering (ICSE 2026)

12/08/2025

Article: **Intelligent Coordination System for Autonomous Domestic Heating: an AI-Driven Test-Bench** ↗

Published at: MetroLivEnv 2025

26/06/2024

Article: **AI/ML for safety-critical software: the case of the space domain** ↗

Published at: IEEE Software

25/09/2023

Article:

A model based approach to sw quality models: from Matlab/Simulink model to quality metrics, an AOCS SW experience

↗

Published at: ESA SW PA Workshop 2023

29/01/2021

Patent: **Dialysis system and method** ↗

28/10/2020

Patent: **Apparatus for pumping and dialysis** ↗

28/10/2020

Patent: **[US] Peritoneal dialysis system and cassettes therefor** ↗

28/10/2020
Patent: **Peritoneal dialysis system and cassettes therefor** ↗

29/04/2020
Patent: **Peritoneal dialysis fluid from concentrate containers** ↗

08 THESES

Master Degree: "Indoor localization with Ultra Wide Band sensors and quadcopter's advanced control: an application with the CrazyFlie"

Bachelor Degree: "Tracking and Visual Servoing of a quadcopter"

09 CERTIFICATIONS

License to practice in "Ingegneria dell'Informazione" obtained on July 2020

10 CONFERENCES & SEMINARS

12-18/04/2026
Participation as an author in **ICSE (International Conference on Software Engineering) 2026**, held in Rio de Janeiro from 12 to 18 April 2026.

22-25/09/2025
Participation as an author in the **ESA SW PA Workshop**, held in Noordwijk from 22 to 25 September 2025.

25-28/09/2023
Participation as an author to **ESA SW PA Workshop**, held in Madrid from 25 to 28 September 2023.

24-27 October 2016
Participation + management and organization of the conference IECON2016, Florence

01-31 July 2016
Participation as a visiting student to different activity at the Harbin Institute of Technology in China

23 March 2016
Participation to the conference RomaDrone, Rome

11 ADDITIONAL EXPERIENCE

Setup of a Linux server with: ISPConfig, Dovecot, Postfix and RoundCube

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TECHNOLOGY STACK

Programming

C C++ Python Ada Rust Dart JavaScript Java

Embedded & platforms

Embedded Linux Yocto / BitBake U-Boot Linux drivers ARM mbed PIC / dsPIC HLS / FPGA

Protocols

I²C SPI UART CAN SpaceWire Ethernet TCP/IP Modbus RS-232 / RS-485

Frameworks & AI

Flutter Django React Node.js Kolmogorov-Arnold Networks

OS & engineering tools

Linux Git Docker Jenkins GNAT Studio GRMON IBM DOORS MPLAB X

Data

MySQL MongoDB Oracle JSON XML

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PROFESSIONAL LINKS

- My official GitHub account: <https://github.com/capriele>
- My official Bitbucket account: <https://bitbucket.org/capriele>
- My official GitLab account: <https://gitlab.com/capriele>
- My official LinkedIn account: <https://www.linkedin.com/in/alberto-petrucci/>