

Internship Proposal: Development of an Online Data Acquisition Platform for Software-Defined Power Converters

Context

The **DataPower project** has led to significant progress in the development of a **software-defined power converter**, which is now fully functional and validated at **TRL 9**.

However, the **online data acquisition platform**—a critical element to enable *intelligent control* and *smart maintenance*—remains at an early research stage (**TRL 2–3**).

The project is also aligned with the broader objectives of the **ANR-funded project ANR-21-CE05-0011**, which investigates power converters as both energy-processing devices and **data sources for machine learning** applications [2].

The figure below illustrates the overall system architecture, where the **green blocks** indicate the parts already completed, the **yellow blocks** the elements started, and the **orange blocks** the modules yet to be developed and consolidated during the internship.

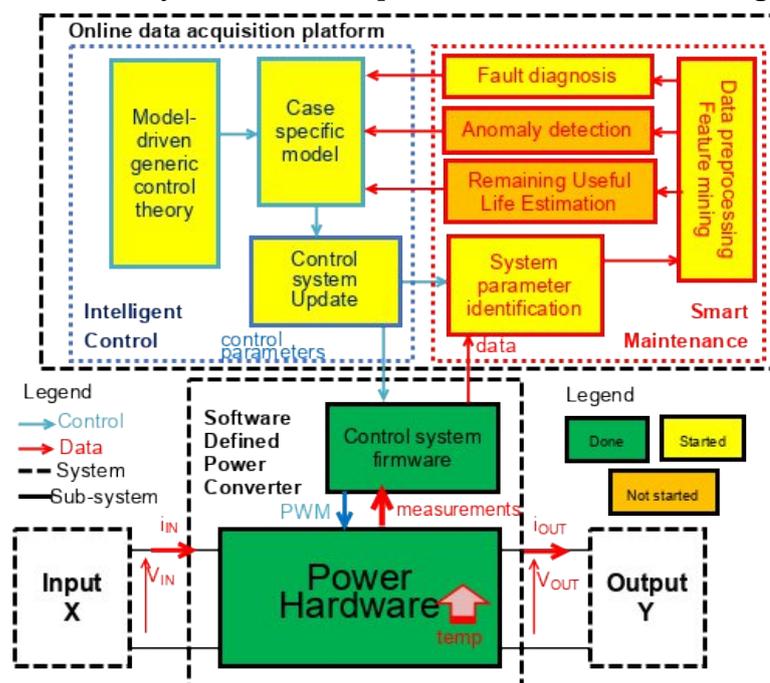


Figure 1. Overall system architecture of the DataPower platform.

Data-Driven Control Principle

Traditional control of power converters requires an accurate mathematical model, which is difficult to derive due to nonlinearities, switching devices, and parameter uncertainties.

Data-driven methods such as **Virtual Reference Feedback Tuning (VRFT)** bypass the modeling stage by relying directly on experimental input–output data [1].

The procedure can be summarized as:

1. **Open-loop excitation:** The converter is excited with a chosen signal (e.g., duty-cycle chirp) to collect representative output data.
2. **Virtual reference estimation:** A desired reference model (M) is assumed, and the corresponding *virtual reference* ($r(t)$) is reconstructed so that the system's measured output could have come from this model.
3. **Error computation:** The *virtual tracking error* ($e(t)$) is computed as the difference between the virtual reference and the actual output.
4. **Controller fitting:** The error is then used to fit the controller (K), so that the closed-loop dynamics approximate the chosen reference model.

This is illustrated in the following block diagram:

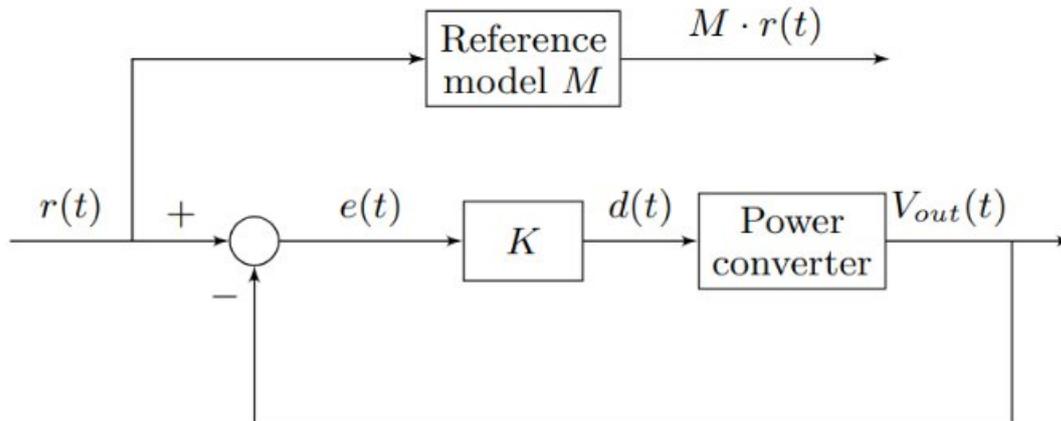


Figure 2. Principle of data-driven control using Virtual Reference Feedback Tuning [2] By using this approach, the intern will help extend the project from a purely model-based stage toward an adaptive system capable of rapid controller synthesis directly from experimental data.

Objectives

The main objective of this internship is to **consolidate and validate the online data acquisition platform** and integrate it with the already operational power hardware and firmware.

This will enable the complete closed-loop of **intelligent control** and **smart maintenance**.

More specifically, the intern will:

Understand the existing system:

- Explore the **power hardware** (software-defined power converter).
- Analyze the **control system firmware**.
Review the **Python-based smart maintenance modules** (parameter identification, diagnosis).
- Study the **MATLAB-based generic control mechanisms**.

Develop and integrate the online data acquisition platform:

- Implement the **model-driven control database** approach as described in the reference article [1].
- Define procedures for **open-loop excitation** of the converter to collect relevant datasets.
Identify **data requirements** (measurements, excitation signals, operating conditions).
- Select and implement **virtual models** suited for different application scenarios.

Validate the closed-loop interaction:

- Demonstrate how the **data-driven smart maintenance** pipeline (parameter identification, anomaly detection, fault diagnosis, life estimation) can update the **intelligent control system**.
- Run a **case study** to illustrate the complete loop from data acquisition → smart maintenance → control update.

Expected Deliverables

A **functional prototype** of the online data acquisition platform integrated with the power converter.

A **case study demonstration** showing the intelligent control + smart maintenance loop in practice.

Documentation of the methodology, including:

- Excitation protocols for data collection.
- Data requirements and preprocessing methods.
- Control database implementation strategy.

A **final internship report** summarizing the results, challenges, and recommendations for further development.

Required Skills

- Background in **control systems** and **power electronics**.
- Experience with **Python** (data acquisition, parameter estimation, diagnostics).
- Experience with **MATLAB/Simulink** (modeling and control prototyping).
- Familiarity with **embedded systems** and **firmware-based control** is a plus.

Impact

By the end of the internship, the project is expected to reach a **higher TRL level** for the online data acquisition platform, bridging the gap between **TRL 2-3** and experimental demonstration.

This will pave the way for a **self-adaptive, intelligent power conversion system** that integrates both *diagnosis* and *control update* in real time, aligned with the methodologies described in recent research [1,2].

References

[1] Marwan Soliman, Pauline Kergus, Zohra Kader, Luiz Villa, Diego Regruto. *Data Driven Control for Power Converters*. Symposium de Génie Electrique (SGE), 2025.

[2] Emmanuel Roux-Palomo, Thomas Walter, Jean Alinei, Luiz Villa. *Des convertisseurs de puissance comme sources de données pour l'apprentissage machine*. SGE, 2023.

[3] ANR project: [ANR-21-CE05-0011](#)