Arc Fault Detection

VEDLIoT
Very Efficient Deep Learning in IoT

An AI-based solution for DC series arc fault detection

OVERVIEW

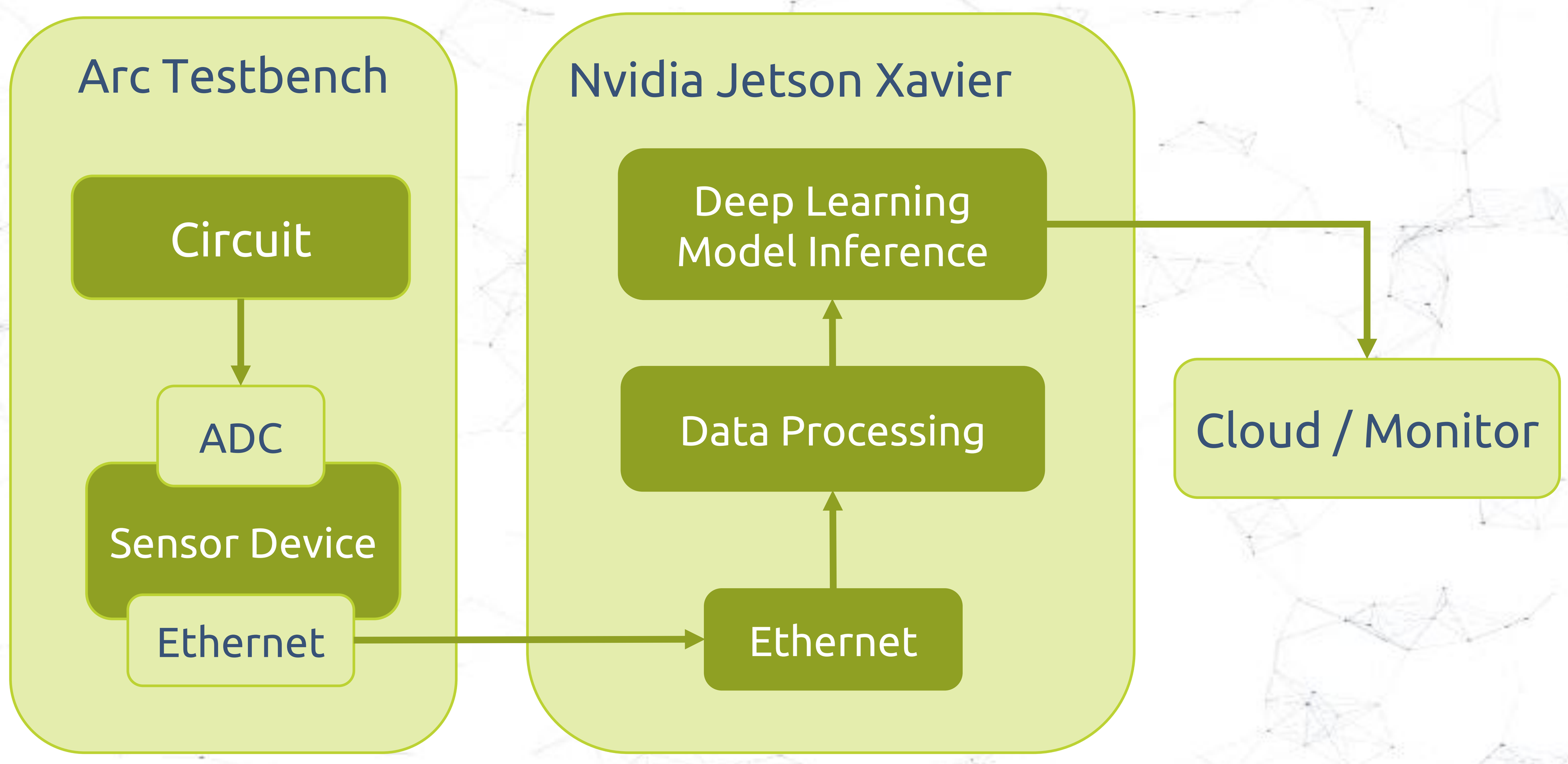
The arc fault detection device aims to provide an AI-based(artificial intelligence) solution for series arc detection in DC (direct current) distribution systems with high accuracy in real-time.

In recent years, DC distribution systems are gaining ground relative to AC (alternating current) distribution systems. Due to the improved efficiencies and the cost-efficient integration of energy storages, DC distribution systems play a significant role in renewable energy production, the ICT-Industry (Information and Communication Technology), and the electro-mobility market.

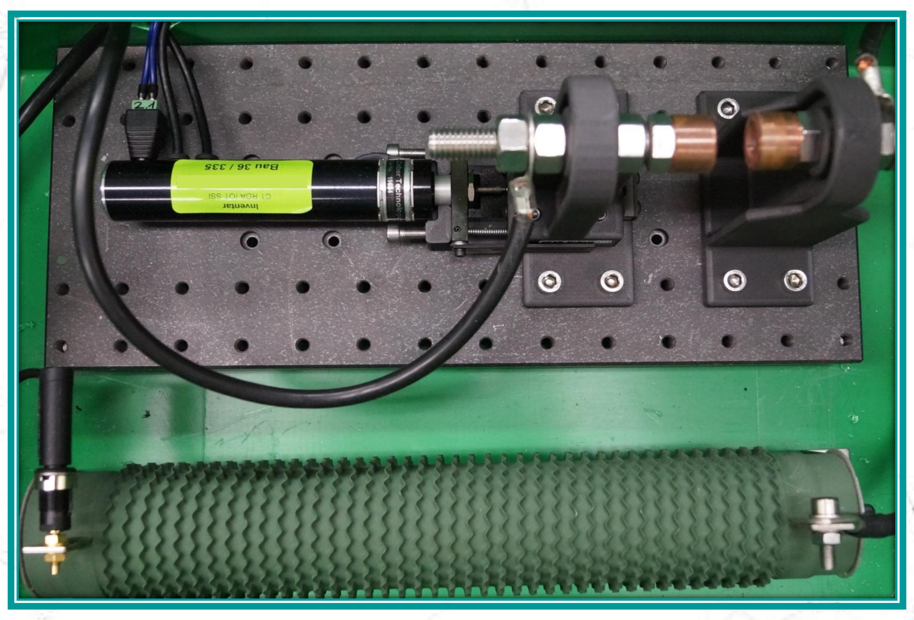
Arc fault detection in DC distribution systems is more challenging compared to AC distribution systems. AC is easier to be detected with the abnormal behaviors such as "flat shoulder" at zero-crossing.

Furthermore, the series arc fault has a higher risk compared to the parallel arc fault. The parallel arc fault (short circuit), or ground arc fault, could easily trigger circuit protection due to high current flow. The current fluctuation caused by the series arc, on the other hand, could easily be covered by system noise and get ignored.

AI-based methods have proved their advantage in similar areas and could be used in arc fault detection. The methodology developed within the VEDLIoT project offers helpful tools for implementing deep learning algorithms in industrial use scenarios, which have high requirements on power consumption, time, and precision.

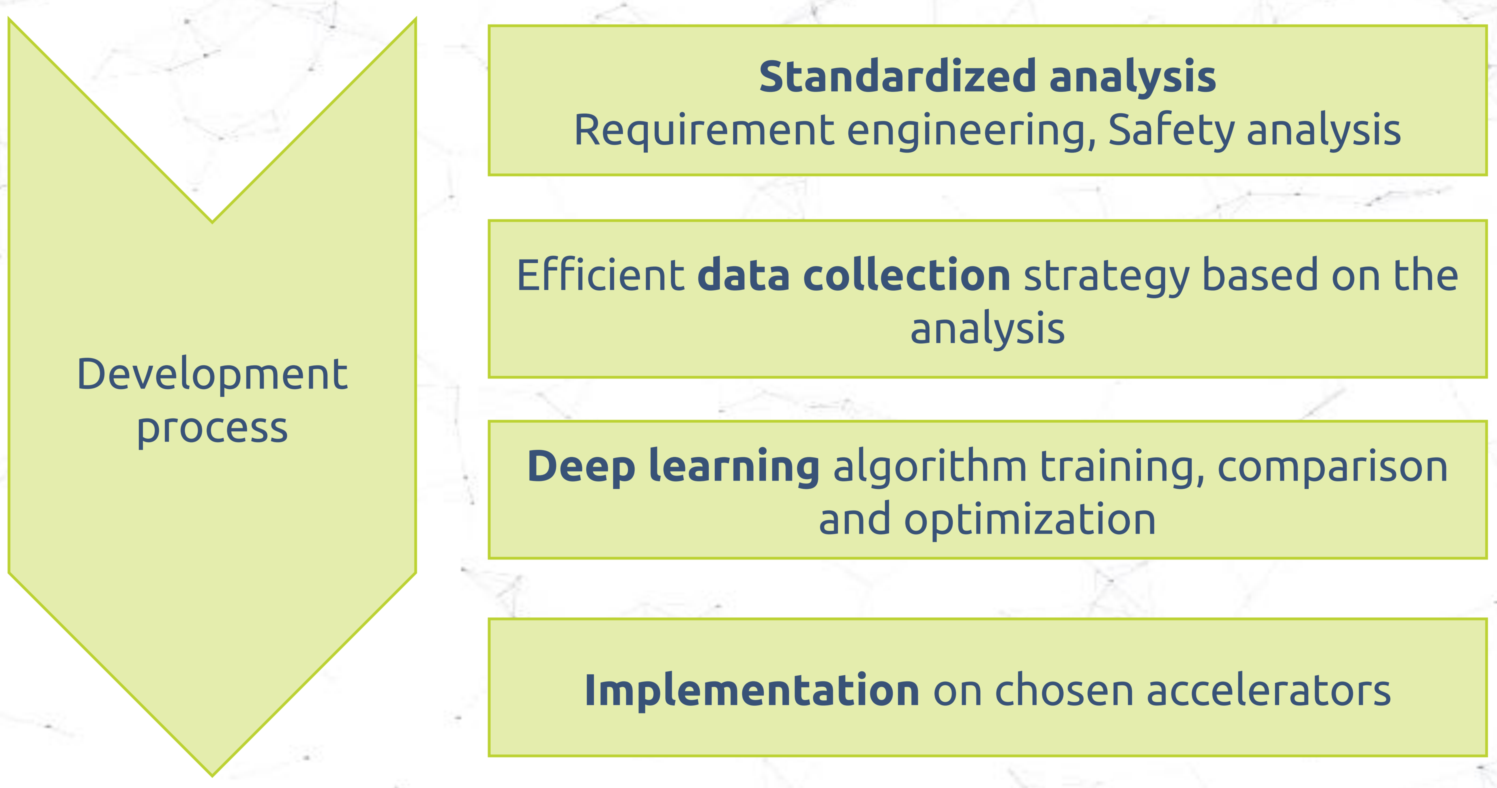


Data flow through the arc generation testbench and the deep learning accelerator

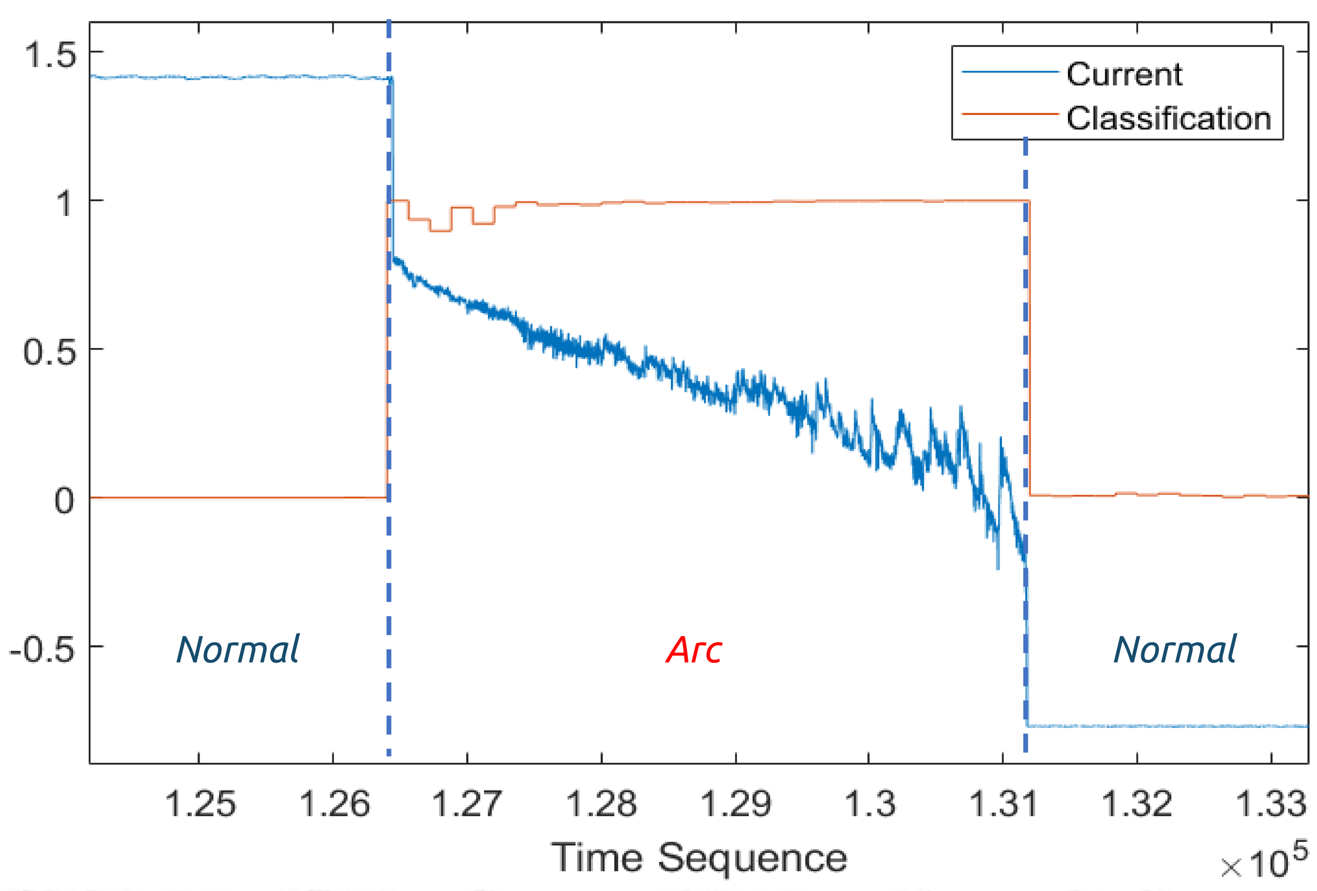


Testbench with motor controlled electrode for arc generation

The deep learning accelerator Nvidia Jetson Xavier for real-time classification



Standardized development procedure from VEDLIoT for AI-based industrial use cases



Arc fault detection based on real time sampled current data
Current: current value collected in real time
Classification: probability output based on the current value in the given time window

Challenges

Arc faults in commercial and industrial settings could cause severe economic consequences and even burns to unprotected personnel. It is important to have the arc fault detected in real-time with high accuracy.

Time critical classification

The flame ignition caused by arc fault could be very fast. Therefore, the time from the start of the arc fault to the execution of the necessary measurement is very limited. The time should be split into actions such as data collection, data transmission, detection model execution, and actuator reaction. In this case, it is important to optimize the deep learning algorithm as well as the hardware platform for local arc fault detection.

Avoid false classification

False negatives and false positives could both cause damage. An undetected arc fault is dangerous. On the other side, a false alarm could also cause an unnecessary system shutdown. Economic loss might happen due to operation breaks; worker safety might also be threatened due to power loss of security equipment. Therefore, precise classification and extra safety monitoring are required.

Big data

Conventional methods for DC series arc fault detection are based on statistical algorithms and have the limitation of use scenarios. AI-based methods provide the possibility for arc fault detection to work under different kinds of DC systems. However, this is supported by big data collected with different system parameters, such as gird topology, load type, voltage level, etc... This amount of data with high variety is usually hard to be collected.

These challenges are also relevant to other industrial use cases and the VEDLIoT project is also actively looking for solutions and including them in the implementation process.

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