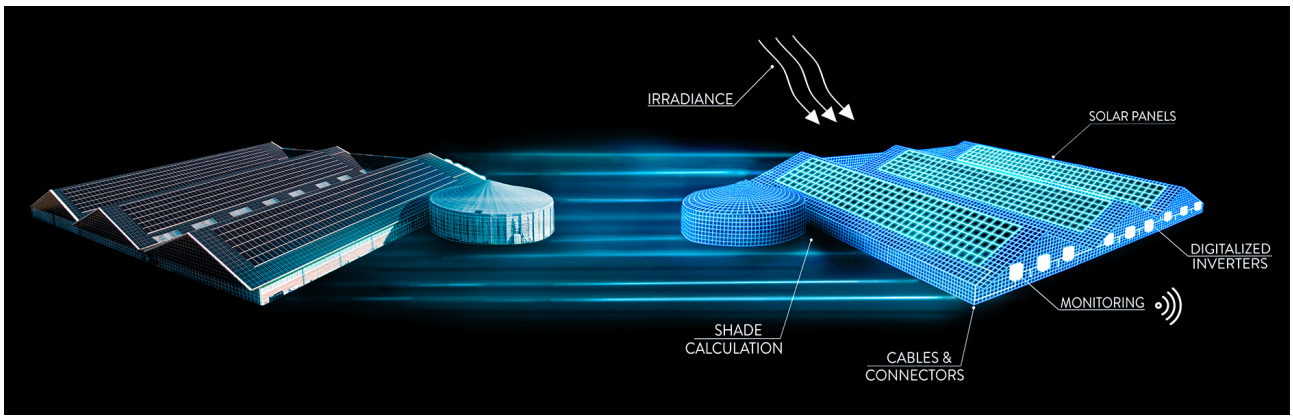
Monitoring of Solar PV Installations

Photovoltaic systems (PVS) are increasingly being installed on every roof. However, the monitoring of a such system has to be done periodically by a service technician. To ensure that the efficiency remains at the maximum, it must be checked regularly. For this purpose, a digital twin has been created which can predict the failures of the system.



PVS illustrated in form of digital twin (source: Autarco)

Digital Twin

A digital twin is similar to a simulation, but with more features and capable of handling more complex tasks. Since the data are constantly submitted, it can obtain the current physical state of the PVS. Although the external information is always up-to-date, it can perform simply as well as its built-in model. The built-in model replicates the physical cell of a PVS.

Dataset

Sets of data are used as training data for machine learning. Different conditions are generated with the digital twin model and weather profile. A plane of array irradiance and cell temperature is extracted from the weather profile. These two components define output data, such as I_{mp} and V_{mp}. The fault condintions are defined. Although the definition is not very accurate compared to practical cases, the outcomes of the faults are similar. Gaussian noise is added to the datasets to resemble the measurement.

Machine Learning

A supervised support vector machine (SVM) algorithm is deployed for fault detection.
The datasets with different conditions are classified with corresponding faults. Cross-validation method attains the highest precision of the classifier. Three classifiers are generated for predicting shadows, fault, and level of soiling.

Monitoring PVS

External Information

- Plant information, type: JSON, dictionary
- Measured data, type: CSV, list of array

Code

- Input: Plant information, measured data from field
- Calibration: measured data from field
- Datasets: normal, soiling, hot spot, and string breakdown
- Prediction:
  - shadow algorithm: normal 78 % and fault 98 %
  - soiling level: light 93 % , medium 80 %, and heavy 97 %
  - faults: none 80 %, soil 99 %, hot spot 98 %, string breakdown 98 %

Project Team:
Tashi Tsching

Client:
Solextron AG, Aarau AG

Coaches:
Prof. Dr. Renato Minamisawa,
Dr. Vipluv Aga