Fault Detection in PV Arrays using Machine Learning Methods

Emma Pedersen, IRES Student
Graduate Mentor: Sunil Rao[1], Yiannis Tofis[2] Faculty Advisor: Andreas Spanias[1]
SenSIP Center - Arizona State University[1], KIOS Center - University of Cyprus[2]

IRES Sensors and Machine Learning

PROBLEM STATEMENT

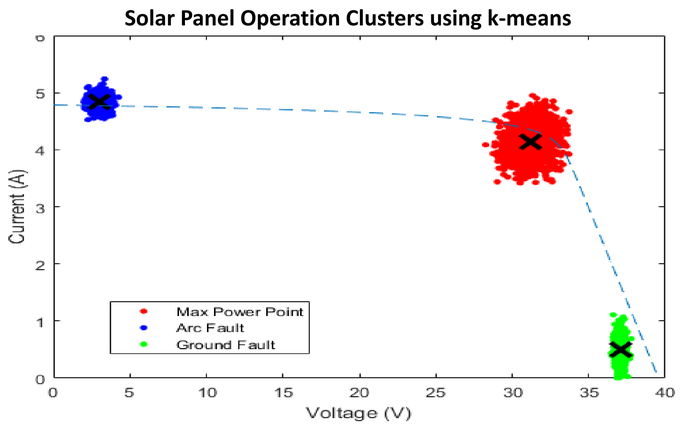
- Current fault detection methods are costly, time-consuming and potentially dangerous
- Rooftop-scale: detection and localization challenging with aggregate data

PROPOSAL

- Study machine learning strategies for fault detection in rooftop installations
- Examine statistical matrix analysis methods to compare normal and faulty power output curves

PRIOR WORK

- Utility-scale: Smart Monitoring Devices with integrated current, voltage, temperature, irradiance sensors



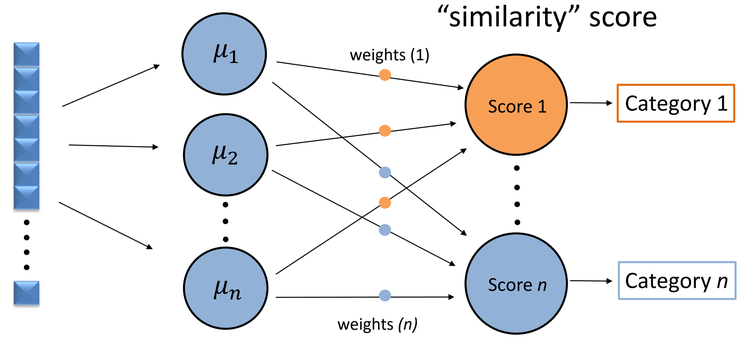
Preliminary Results obtained using *k*-means algorithm

- *k*-means can detect and identify ground faults and arc faults from MPP
- Need for labeled dataset to detect a wider range of faults

Input Vector: shown to each RBF neuron

RBF Neurons: stores prototype, μ_n

Weighted Sums: weighted sum of input values contributes to "similarity" score

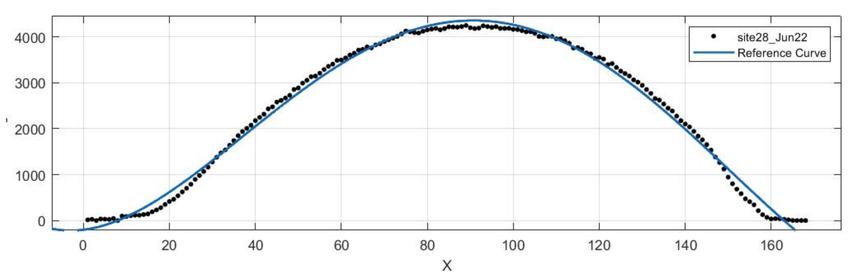


Overview of RBF network architecture

- Supervised approach using Radial Basis Function Network
- Differentiate between standard testing conditions, fully shaded, and degraded modules

RESULTS

- Plot total active power output for each site
- Sunny day reference curves based on location and time of the year



Site 28 reference curve created from curve-fitting power output

- Can be used to compare normal/faulty power outputs

DATASET DESCRIPTION

- Dataset provided by Eletoyia Photovoltaics
- Household PV installations across Cyprus

date	totalActivePower	dcVoltage	groundFaultResistance	powerLimit	totalEnergy	temperature	inverterMode
'2019-06-2...	41.9420	383.5210	11000	100	2640970	43.9494	'MPPT'
'2019-06-2...	55.9019	380.5620	11000	100	2640980	44.3207	'MPPT'
'2019-06-2...	81.5973	381.7310	11000	100	2640980	44.6932	'MPPT'
'2019-06-2...	109.3400	382.9460	11000	100	2640990	45.0037	'MPPT'
'2019-06-2...	139.4800	381.6700	11000	100	2641000	45.2932	'MPPT'

Example of included data for a site

- Above data for any date/time loaded into MATLAB for analysis
  - Site location, panel layout, etc. available
- Daily energy production, mean, and standard deviation calculated and used in:
  - Statistical methods
  - Clustering/Neural Networks

CONCLUSION/FUTURE DIRECTION

- Study data for fault detection and localization
- Cluster data into azimuth groups to determine:
  - When shading starts to negatively impact power
  - Quantify reduction of energy yield

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