Machine Learning for Rooftop PV Fault Detection

Michael Oberdorf, Sunil Rao, Yiannis Tofis, Andreas Spanias, Elias Kyriakides

SenSIP Center, School of ECEE, Arizona State University. KIOS Center, University of Cyprus

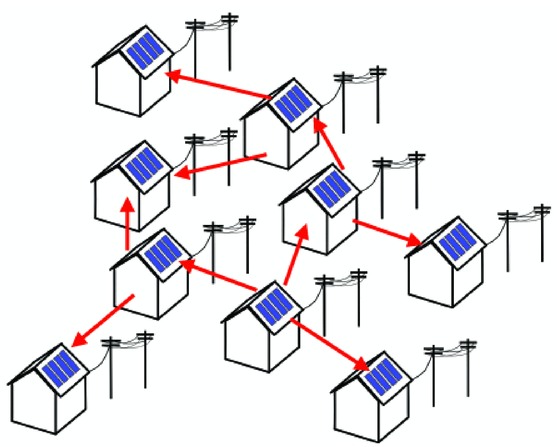
STATEMENT OF PROBLEM

Partial shading in PV array systems

- **Create reliable fault detection methods to increase efficiency of solar energy.**
- **Accurately detect when partial shading is occurring.**
- **Shading causes reduced power from the modules not outputting the same voltage.**

PRIOR WORK

- **Using near neighbor communications on aggregated data from households in the same zip code to identify faults/partial shading.**
- **Using a Radial Basis Function Network to detect conditions such as soiling/shading.**

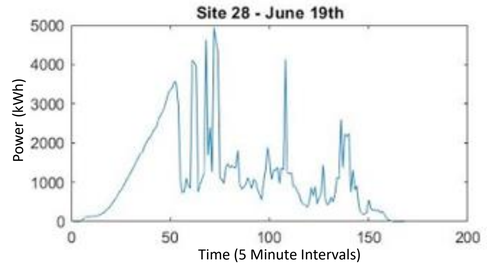


PROPOSED RESEARCH

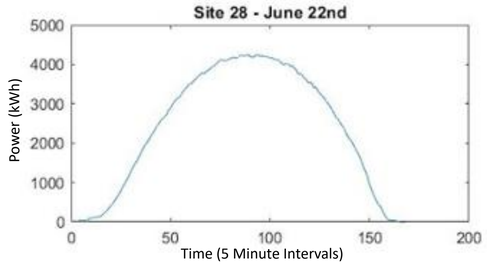
Data Collection

- **Use Data from *SolarEdge* to form different PV azimuth clusters for fault detection.**
- **Identify sunny days near the Summer Solstice for maximum daylight time.**
- **Normalize data of sunny days that was collected from numerous PV sites.**
- **Apply K-means algorithm on to the data.**

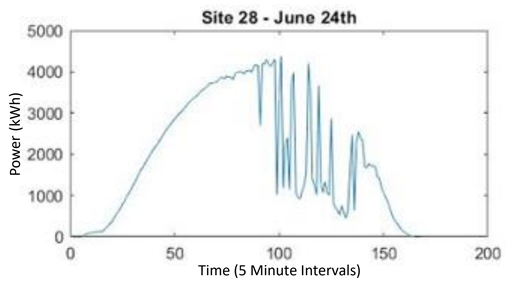
Rainy Day



Sunny Day

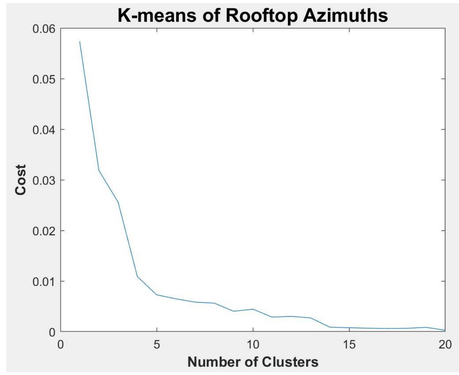


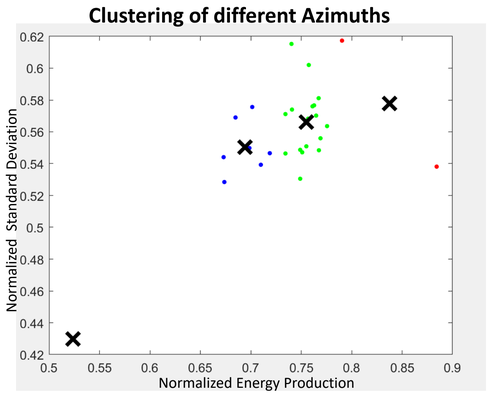
Cloudy Day



RESULTS

- **Preliminary k-means clustering results indicate a separation between faulty and normal conditions**





CONCLUSION

- **Gained experience on basic machine learning techniques.**
- **Determined from statistics of data how many clusters to use.**
- **Knowledge gained of array setups and numerous types pf PV faults.**
- **Learning MATLAB coding and applied the skills to real world applications.**
- **Presented material in an international setting at the 12th annual CWSPI.**

FUTURE WORK

- **Gather more information from PV sites for sunny days throughout a year to create better K-means clustering.**
- **Compare PV sites with similar azimuths to detect partial shading.**

REFERENCES

[1]H.Braun,S.T.Buddha,V.Krishnan,A.Spanias,C.Tepedelenlioglu,T.Takehara,S.Takada,T.Yeider,andM.Banavar,SignalProcessingforSolarArrayMonitoring,FaultDetection,andOptimization,ser.SynthesisLectures onPowerElectronics,J.Hudgins,Ed.Morgan&Claypool,vol.3,no.1,Sep.2012.

[2] U. Shanthamallu, A. Spanias, C. Tepedelenlioglu, M. Stanley, "A Brief Survey of Machine Learning Methods and their Sensor and IoT Applications," Proc.s 8th IEEE IISA2017, Larnaca, August 2017.

[3] R. Ramakrishna, A. Scaglione, A. Spanias, and C. Tepedelenlioglu, "Distributed Bayesian Estimation with Low-Rank Data: Application to Solar Array Processing," ICASSP 2019 - 2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp. 4440–4444, Apr. 2019.

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