Algorithms for Maximum Power Point Tracking through Load Management

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Introduction

A common feature in solar photovoltaic (PV) systems is its intermittent nature. Several storage and supportive technologies have been developed to smooth this generation, but these devices are not cost-effective and results in power loss. Professor Tao's research team at ASU have developed a new maximum power point tracking (MPPT) topology by managing the loads connected to a PV systems that will bypass this. This project was aimed to improve this control method and developing an efficient feedback-based control algorithm for the Load Management PV System.

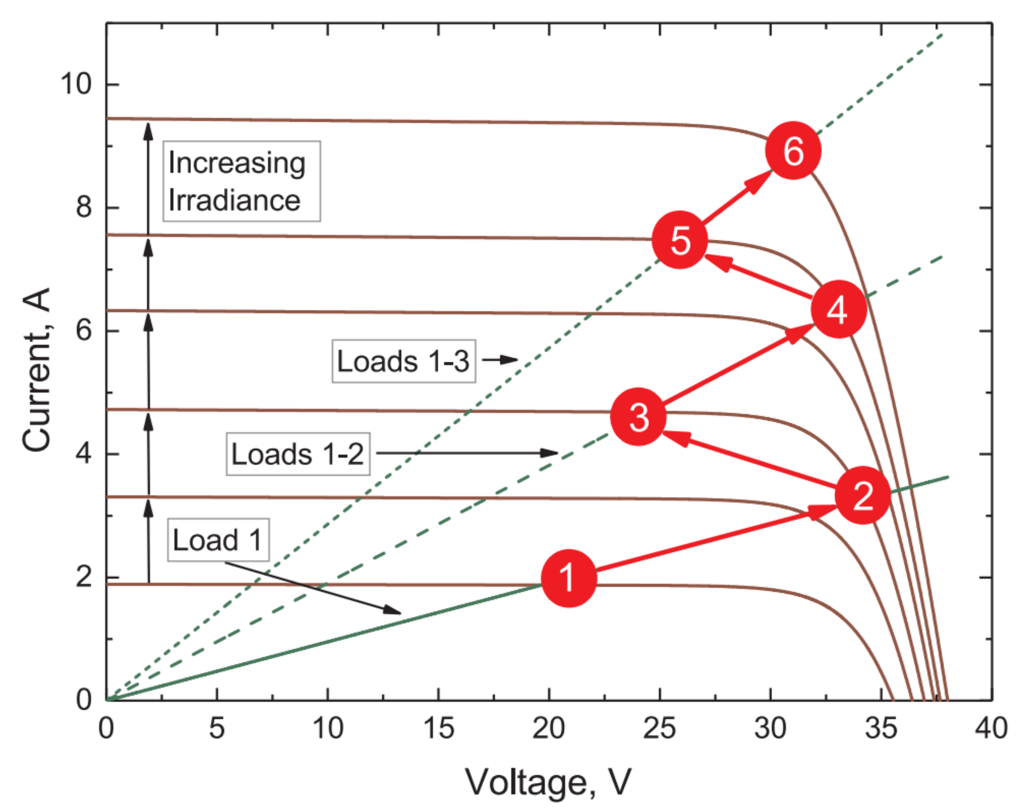


Fig. 1: A Load-line analysis for a LMPV system with three DC loads.

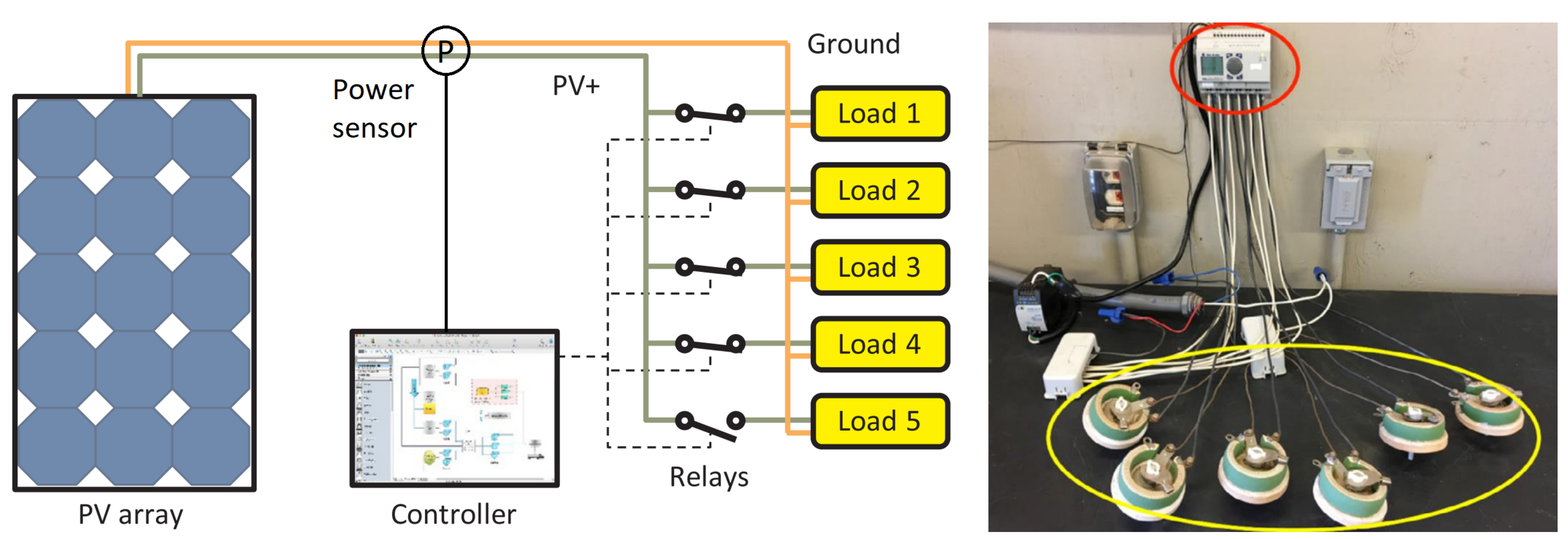


Fig. 3: A basic stand-alone LMPV system with five DC loads.

Challenges with Previous System

In the first prototype of the LMPV system, the control algorithm was based around the signal from the photodetector. However, any small variation on the photodetector affect the accuracy and efficiency of the system; these variations include shading, snow, rain, dust, falling leaves, bird dropping, etc. are difficult to eliminate.

Solution: Feedback-based System

The feedback-system will contain a power sensor that tracks the PV system's power over time. The controller will connect or disconnect loads, compare the powers before and after the switch, and performs MPPT by proceeding with the higher power.

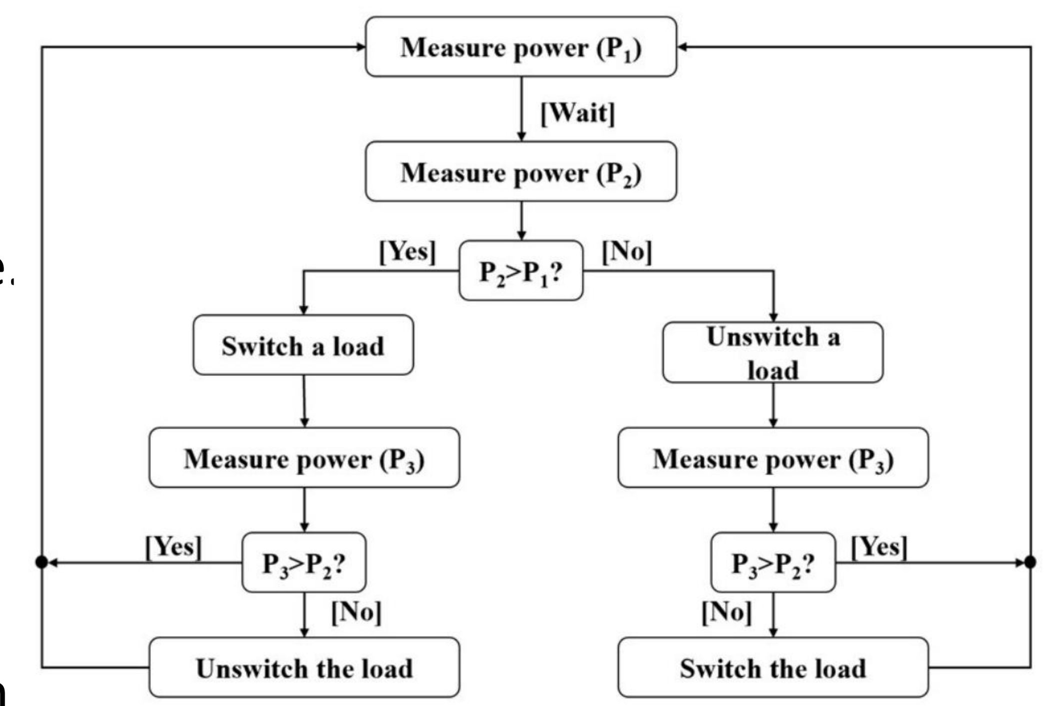


Fig. 2: The block diagram the algorithm that analyzes PV power over time

Improvement Strategies

The feedback-based approach was able to perform MPPT well, but the rudimentary algorithm had the following problems:

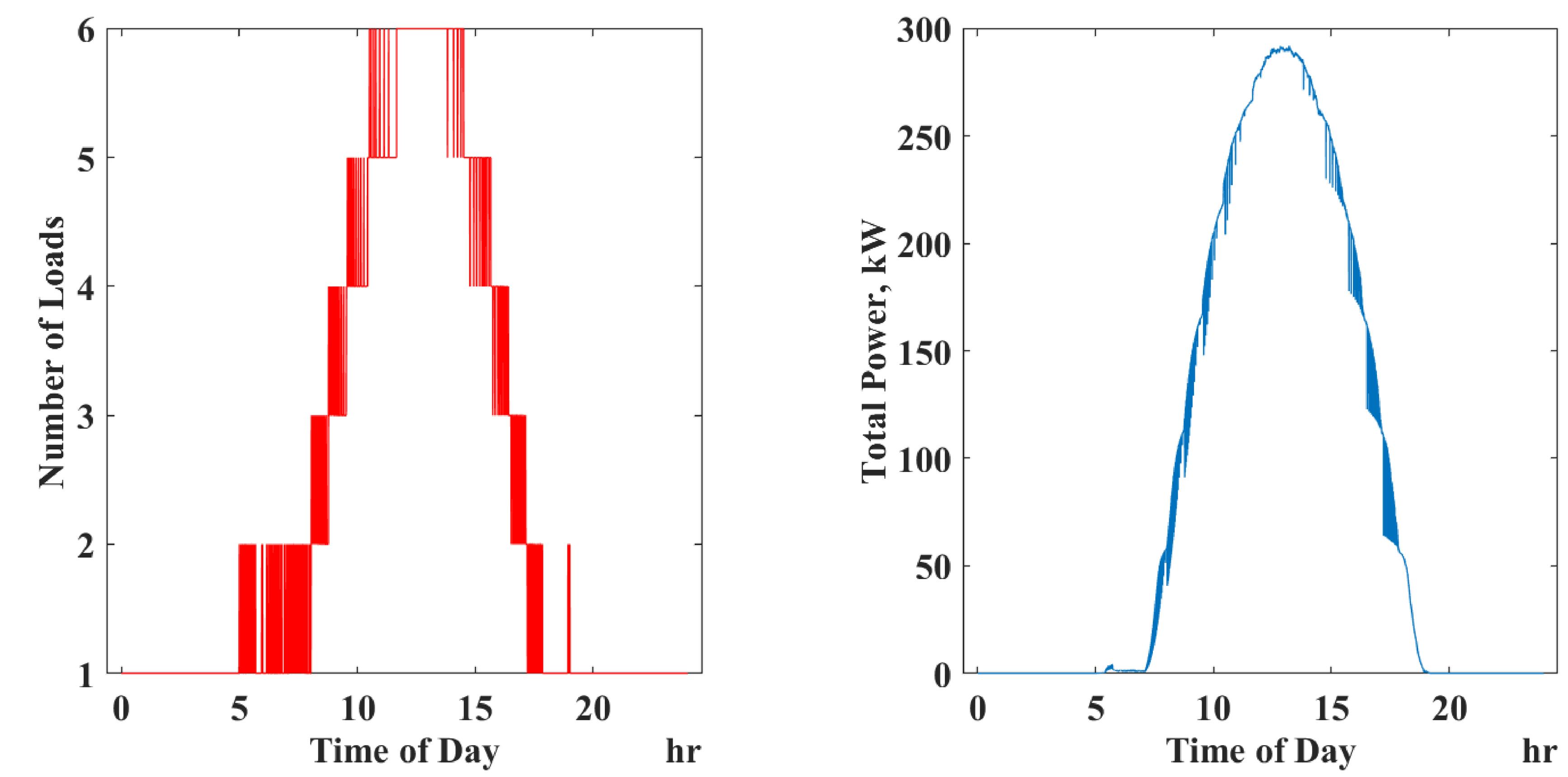
- Premature switches (PS) – when the systems switches a load and finds power does not increase.
- Faulty switches (FS) – when PV power is increasing, but noise from the sensor causes the system to disconnect a load.

Several improvement strategies were investigated to reduce the losses from PS and FS; these include **a time delay between power measurements**, **averaging multiple power measurements**, and a **power threshold** before attempting a switch.

Our findings

The proposed strategies for improvements **reduced premature switches and eliminated faulty switches successfully.**

The optimal parameters for PV system with six equal DC loads were a delay time of 10s, 350Hz sampling frequency, and a power threshold of 2%. The finding also show that increasing the number a loads will need a sequential decline in the magnitude of the power threshold for an optimal system.



Future Improvements and Applications

Future improvements:

- Sophisticated Algorithm that can predict the next switch points
- Support different type of DC and AC loads
- Implement memory or other improvements to increase efficiency

Applications:

- Electric vehicle charging
- Efficient energy storage application through hydrogen production: Electrolysis
- Cost effective and efficient MPPT system for PV systems

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