Unbounded Binary Search for a Fast and Accurate Maximum Power Point Tracking

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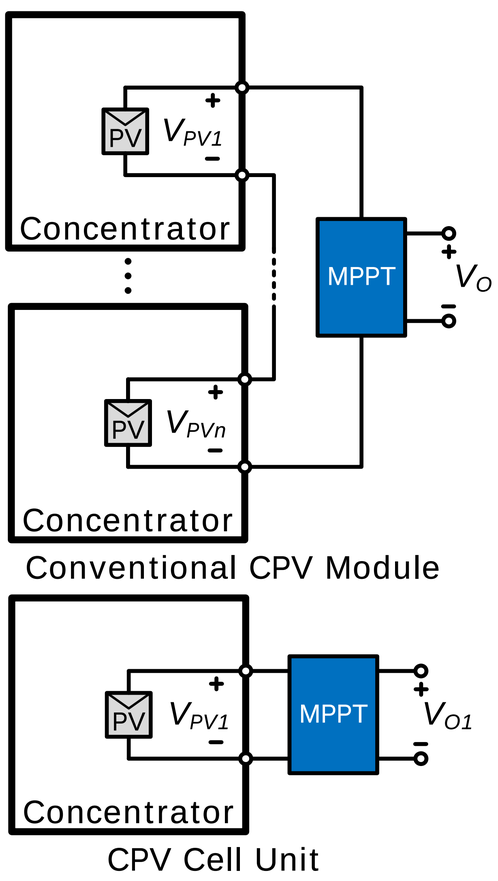
Abstract

This paper presents a technique for maximum power point tracking (MPPT) of a concentrating photovoltaic system using cell level power optimization. Perturb and observe (P&O) has been a standard for an MPPT, but it introduces a tradeoff between the tacking speed and the accuracy of the maximum power delivered. The P&O algorithm is not suitable for a rapid environmental condition change by partial shading and self-shading due to its tracking time being linear to the length of the voltage range. Some of researches have been worked on fast tracking but they come with internal ad hoc parameters. In this paper, by using the proposed unbounded binary search algorithm for the MPPT, tracking time becomes a logarithmic function of the voltage search range without *ad hoc* parameters.

Motivations



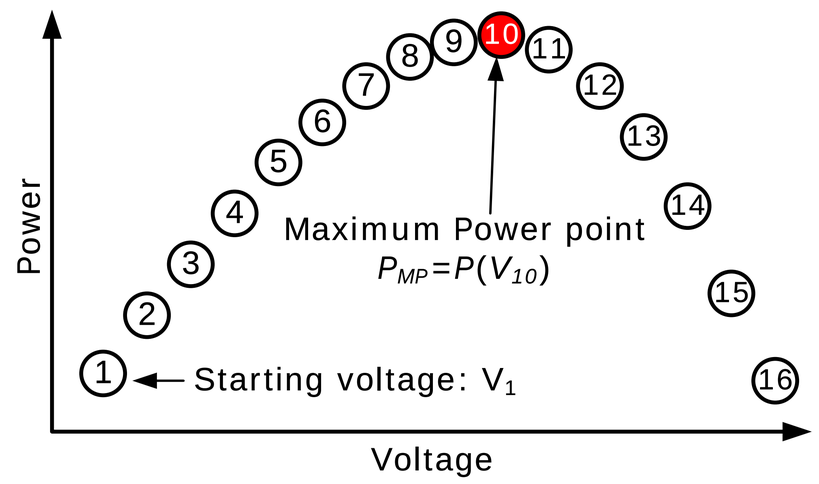
- Maximum power point tracking (MPPT) for each CPV cell
- Fast and accurate MPPT
- No ad hoc parameter

MPPT Algorithms

- **Perturb and Observe (P&O)**
  - –Simplest
  - –The reference voltage is perturbed in a direction and the powers of consecutive samples are compared
  - –It keeps its direction only if the later sample has higher power. Otherwise the direction needs to be reversed.
  - –A tradeoff in dynamic range and tracking time exists
  - –Not suitable under rapidly changing atmospheric conditions
- **Variable Step (VB)**
  - –racking speed is enhanced by increasing the voltage steps
  - –*ad hoc* parameters are introduced so that an external control required
- **The Proposed Unbounded Binary Search (UBS)**
  - –Voltage steps change automatically

Maximum Power Point Tracking

- **Power vs. Voltage**



- **Tracking Procedure**

Perturb and Observe: voltage step=1

1 2 3 4 5 6 7 8 9 10 11 10 9 10 11

Variable step: Voltage step=4→1

1 5 9 13 12 11 10 9 10 11 10 9 10 11 10

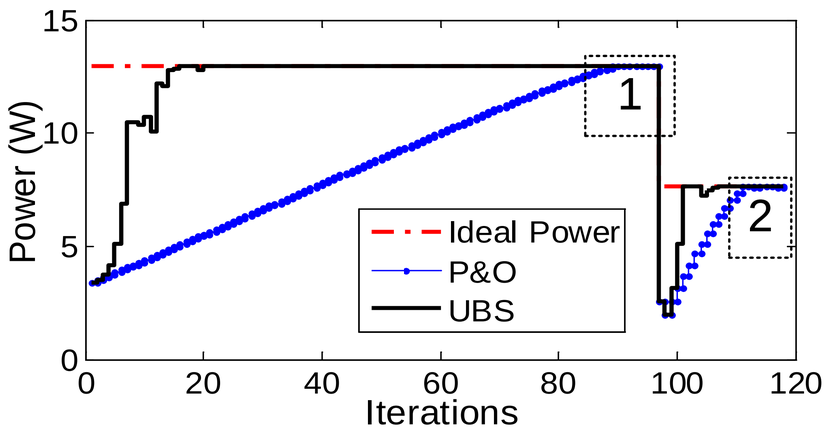
The proposed (UBS):
Voltage step=2→4→8→4→2→1

1 3 7 15 8 12 10 9 11 10 10 10 10 10 10

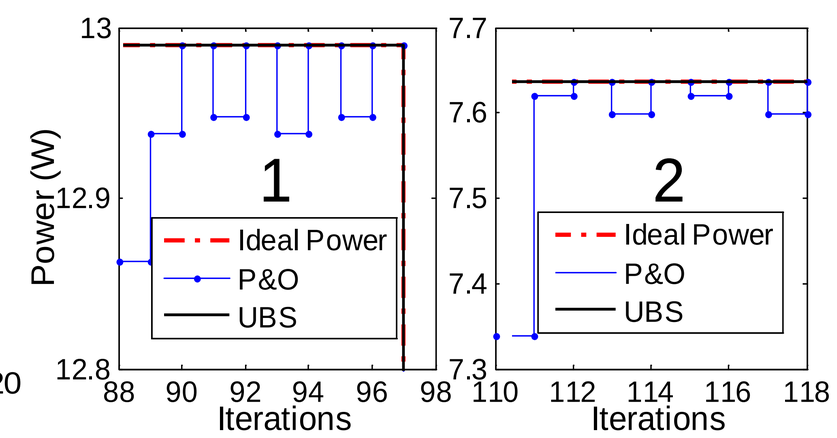
Simulations

- **Simulation scenario**
  - –DNI=850W/m²
  - –Iteration 0
    - ▪Partial shading
    - ▪3/4 of a cell shaded
  - –Iteration 90
    - ▪Partial shading condition is released
    - ▪DNI is reduced to 60%

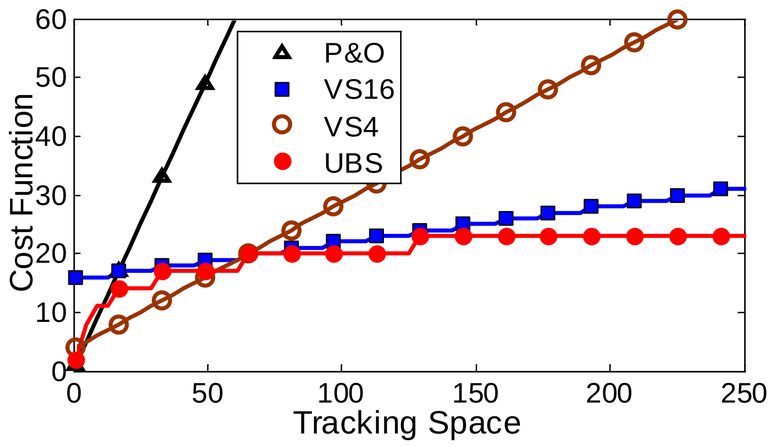
- **Simulation results**



- **Zoom-in View**



Comparison



Flow Chart