Synchronized Phasor Measurement Units

Implementation Of Phasor Measurement Unit Function On An HVDC Control Platform

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ABSTRACT

(Filler text not actual text) During recent years, for photovoltaic (PV) systems, many maximum power point tracking (MPPT) algorithms have been proposed and developed to maximize the produced energy. Regarding the design manner, these methods vary in many aspects as: implementation simplicity, power or energy efficiency, convergence speed, sensors required, cost effectiveness. Some comparative studies, based on widely-adopted MPPT algorithms, presented in the literature give results obtained either from simulation tool, which provide simultaneous operating systems, or using real PV test bench under solar simulator in order to reproduce the same operating solar conditions. This work presents an experimental comparison, under real solar irradiation, of four most used MPPT methods for PV power systems: Perturb and Observe (P&O) and Incremental Conductance, as tracking step constant, and improved P&O and Fuzzy Logic based MPPT, as variable tracking step. Using four identical PV, under strictly the same set of technical and meteorological conditions, an experimental comparison of these four algorithms is done. Following two criteria, energy efficiency and cost effectiveness, this comparison shows the advantage of use of a MPPT with a variable tracking step. The extracted energies by all four methods are almost identical with a slight advantage for improved P&O algorithm.

Keywords: DSC, MPPT, PnO.

ACKNOWLEDGMENTS

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ACRONYMS

DSCs	Dye-Sensitized Solar Cells . . . 1
MPPT	Maximum power Point Tracking . . . 1
CdTe	cadmium telluride . . . 1
CIGS	copper-indium-gallium selenide . . . 1
CIS	copper-indium sulphide . . . 1
a-Si	amorphous silicon . . . 1
MPP	Maximum Power Point . . . 3
PnO	Perturb and Observe . . . 6
FOCV	fractional open circuit voltage . . . 6
ICM	Incremental Conductance Method . . . 6

1 INTRODUCTION

This chapter gives a basic introduction to Dye-Sensitized Solar Cells (DSCs) and Maximum power Point Tracking (MPPT).It also defines the scope, Goals, Objective and the Research Methodology for the thesis.

1.1 BACKGROUND

Our ever increasing reliance on electrical and electronic equipment intensified our search for new sources of energy. Dwindling fossil-fuel reserves are not something we can rely on in the long-term.Alternate energy sources must be efficient,cost-effective and ecologically friendly.The Harnessing of solar energy becomes a very attractive proposition.A moderately efficient solar cell array (8%-10% efficiency) Covering a small portion of the earth's surface would be able to provide an enormous amount of electric power and thus reduce greenhouse-gas emissions [3]. However, the current high cost of solar panels made from traditional inorganic semiconductors imposes a restriction on their mass usage. **picture about the losses Solar energy intercepting Earth [toivola2010dye]**

1.1.1 Dye-Sensitized Solar Cells(DSCs)

Photovoltaic devices are based on the concept of charge separation at an interface of two materials of different conduction mechanism. To date this field has been dominated by solid-state junction devices, usually made of silicon, and profiting from the experience and material availability resulting from the semiconductor industry. The dominance of the photovoltaic field by inorganic solid-state junction devices is now being challenged by the emergence of a third generation of cells, based, e.g. on nano-crystalline oxide and conducting polymers films [2]. Crystalline silicon being the first; and thin film technologies such as cadmium telluride (CdTe), copper-indium-gallium selenide (CIGS), copper-indium sulphide (CIS) and amorphous silicon (a-Si) being examples of the second generation [5].

Solar energy can be converted into electricity by a variety of technologies that can also be divided into four classes: Concentrator systems, wafer-based crystalline silicon, thin-film technologies, and emerging technologies[6].

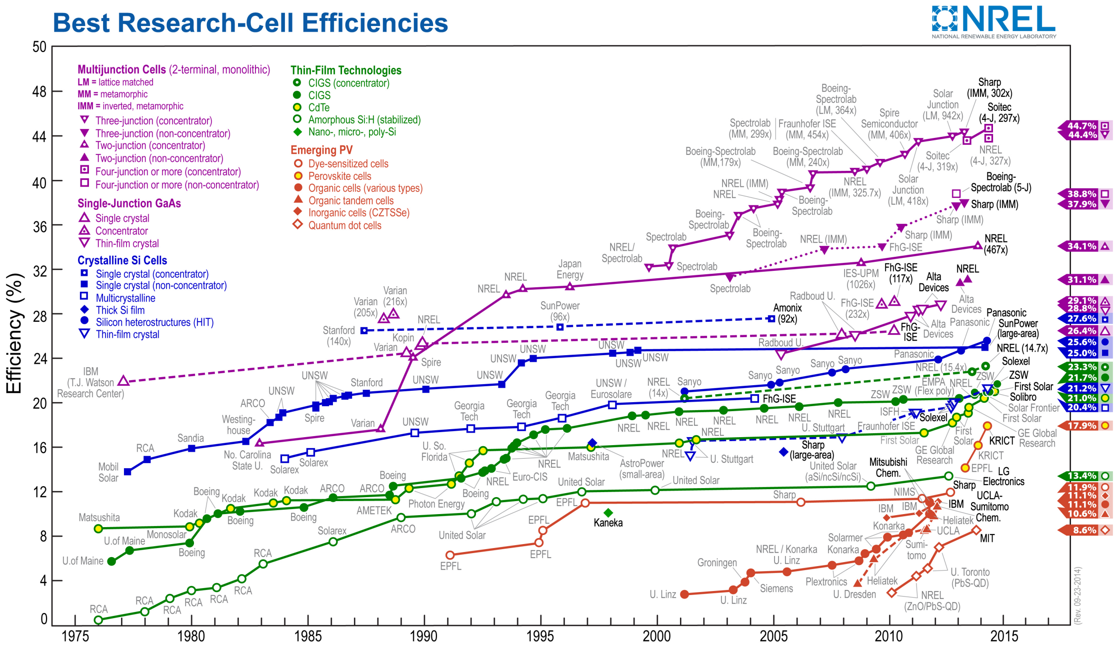

Figure 1.1: Research Cell Efficiency Records [4]

Dye-sensitized solar cells(DSCs) are the most promising of the third and latest generation of solar cells. Under development for the last 20 years, this technology is ready for large scale commercialization to provide robust, efficient, and affordable solar energy to the masses. unlike previous generation cells, DSCs is a Photo-electro-chemical device whose principal of operation is similar to Photosynthesis seen in plants.

1.1.2 Advantages of DSCs

The *** of solar cells is slow **.A major contributing factor for this is the predominant type of solar cells used today -ones made from silicon, which are quite expensive and are complex to manufacture. This has lead to intensive research in to alternative solar cells in the past decade. DSCs have many advantages over their 1st and 2nd generation counterparts. They offer transparency, low cost, and high power conversion efficiencies under cloudy and artificial light conditions.DSCs work even in low-light conditions such as non-direct sunlight and cloudy skies.They are easy and economical to manufacture,with the major constituent materials available in abundance in most counties. **This availability of Raw material also enables us to scale the manufacturing to Tera-Watts levels relatively simple.Since raw-materials are non-toxic and there are no noxious emissions during manufacturing-Sustainable**

		Performance			
		World record efficiency	Module efficiency	Sensitivity to light angle and condition	Sensitivity to temperature fluctuations
1st generation PV	Mono-crystalline silicon	30.0%	19.5%	High	- 0.53% / °C
	Multi-crystalline silicon	18.0%	13.0-15.0%	High	- 0.44% / °C
2nd generation PV	Cadmium telluride	17.3%	13.5%	Medium	- 0.27% / °C
	CIGS	20.3%	15.1%	Medium	- 0.42% / °C
	Amorphous silicon	13.0%	5.0-7.0%	Medium	- 0.20% / °C
3rd gen.	DSCs	14.14% (15%)	10.3%	Low	+ 0.1% / °C

Figure 1.2: Three generations of cells – Performance

**Add more details about Advantage of DSC over conventional cells **

1.2 MAXIMUM POWER POINT TRACKING(MPPT)

A photovoltaic (PV) array that functions under uniform radiation and temperature conditions presents an I–V and P–V characteristic as the one shown in Figure 1.3 and Figure 1.5,respectively. As can be observed, there is a single point, called Maximum Power Point (MPP), where the array provides the maximum power possible for these environmental conditions (radiation and temperature), and so functions with the maximum performance. When a load is connected directly to a PV array (direct coupling), the operation point is defined by the intersection of its I–V characteristics, as shown in Figure 1.3. In general, this operation point does not coincide with the MPP. Thus, in direct coupling systems, the array must be over-dimensioned to guarantee the power demand of the load. Obviously, this implies a more expensive system. To solve this problem, a DC/DC converter with an algorithm for the automatic control of its duty cycle "δ" is inserted between the photovoltaic array and the load , resulting in what is known as MPPT system. The MPPT must control the voltage or current (through the δ the converter) of the PV array regardless of the load, trying to place it in the MPP.Therefore,the MPPT must find the optimal δ for the operation point of the PV array to coincide with the MPP[1].

Although the solution to operating in the MPP may seem immediate, it is not. This is because the location of the MPP in the I–V curve of the PV array is not known a priori. This point must be located, either by mathematical calculations over a valid model, or by using some search algorithm. This implies even more difficulty if we consider the fact that the MPP presents non-linear dependencies with temperature and radiation[1]

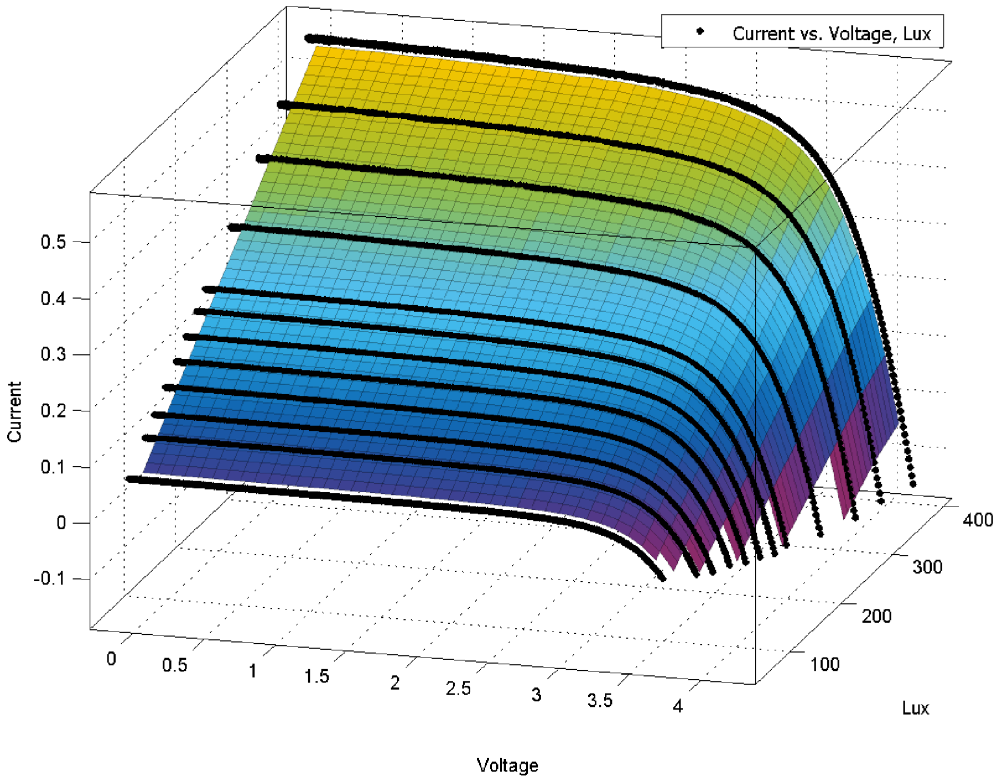

Figure 1.3: I-V-Lux

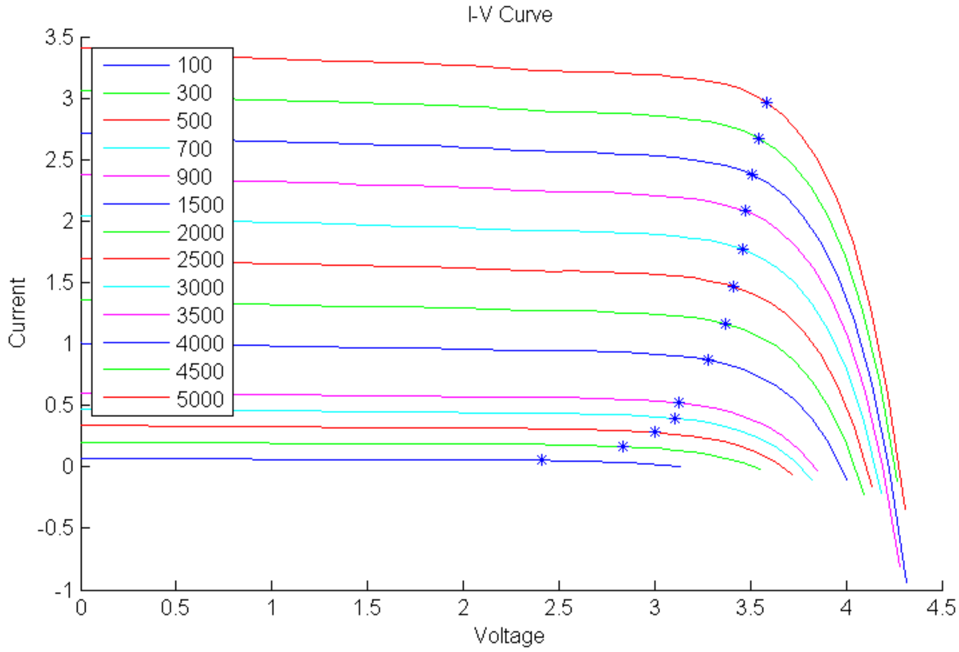

Figure 1.4: I-V Graph, MPPT marked with '*'

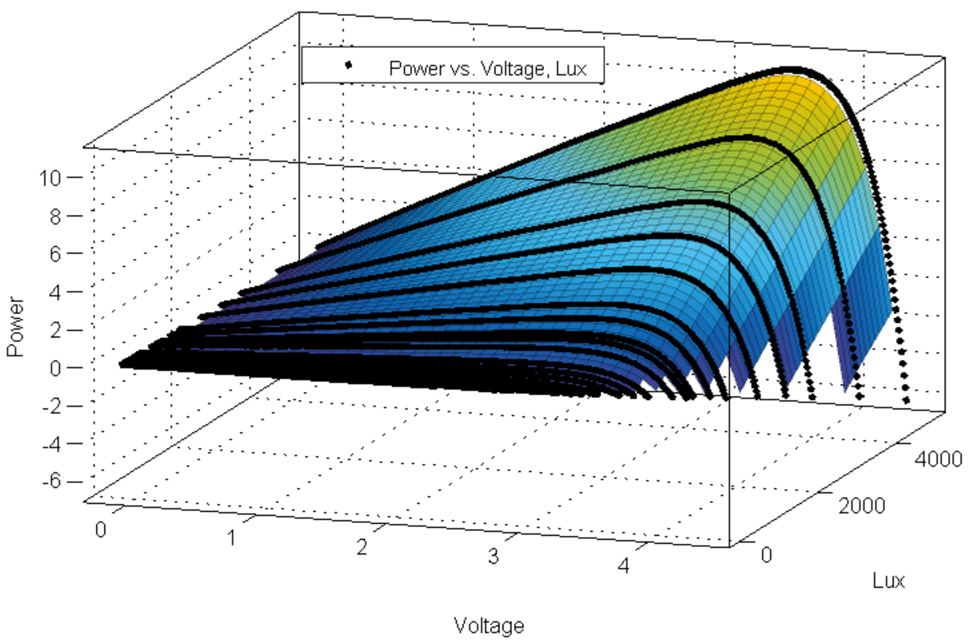

Figure 1.5: P-V Lux

As such, many MPPT methods have been developed and implemented. The methods vary in complexity, sensors required, convergence speed, cost, range of effectiveness, implementation hardware, popularity, and in other respects. They range from the almost obvious (but not necessarily ineffective) to the most creative (not necessarily most effective). In fact, so many methods have been developed that it has become difficult to adequately determine which method, newly proposed or existing, is most appropriate for a given PV system.Some of the most popular being:

- Perturb and Observe Method
- Incremental Conductance Method
- fractional open circuit voltage Method
- Fixed duty cycle Method
- Pilot cell Method
- Pilot cell Method
- Fractional short-circuit current Method
- Fuzzy logic controller

1.3 SCOPE, THESIS GOALS AND OBJECTIVES

This thesis focuses on the finding a practically **optimal** and usable MPPT algorithm that is optimised to be used with the current DSCs.

The objectives of the thesis can be summarized as:

- Develop an Electrical model for DSCs and verify the accuracy of said model.
- Compare and optimize the following Maximum power point tracking (MPPT) algorithms for compatibility with the above Model using MATLAB® and Simulink®.
  1. Perturb and Observe (PnO) Method.
  2. Incremental Conductance Method (ICM).
  3. fractional open circuit voltage (FOCV) Method.
- Setting up the test environment
- Execution of test cases on prototype developed, based on two of the best optimized algorithm, with recordable test results.
- Develop Reference designs for production.
- Internal report.
- Master thesis report.

1.4 THESIS OUTLINE

- Chapter 1 Presents the background and the main objectives of this thesis
- Chapter 2 Contains the prior research and literature that this thesis was based on, it also discusses the principle of operating principles/state-of-the-art of DSCs and of MPPT
- Chapter 3 concerns the research methods, measurement techniques and implementation of the thesis.
- Chapter 4 Gives a summary of the results.
- The thesis is Concluded and Future Work talked about in Chapter 5

1.5 RESEARCH METHODOLOGY

The implementation of the thesis is **

- Develop a suable model for the DSCs based on either:.
    1. the single diode equation for DSCs.
    2. based on experimental modelling Methods .
- objective study of current algorithms; weigh their pros vs cons.
- Validation of the Model and algorithm in MATLAB® and Simulink®.
- Implementation in test Hardware .

2 RESULT DISCUSSION

2.1 PERTURB AND OBSERVE METHOD

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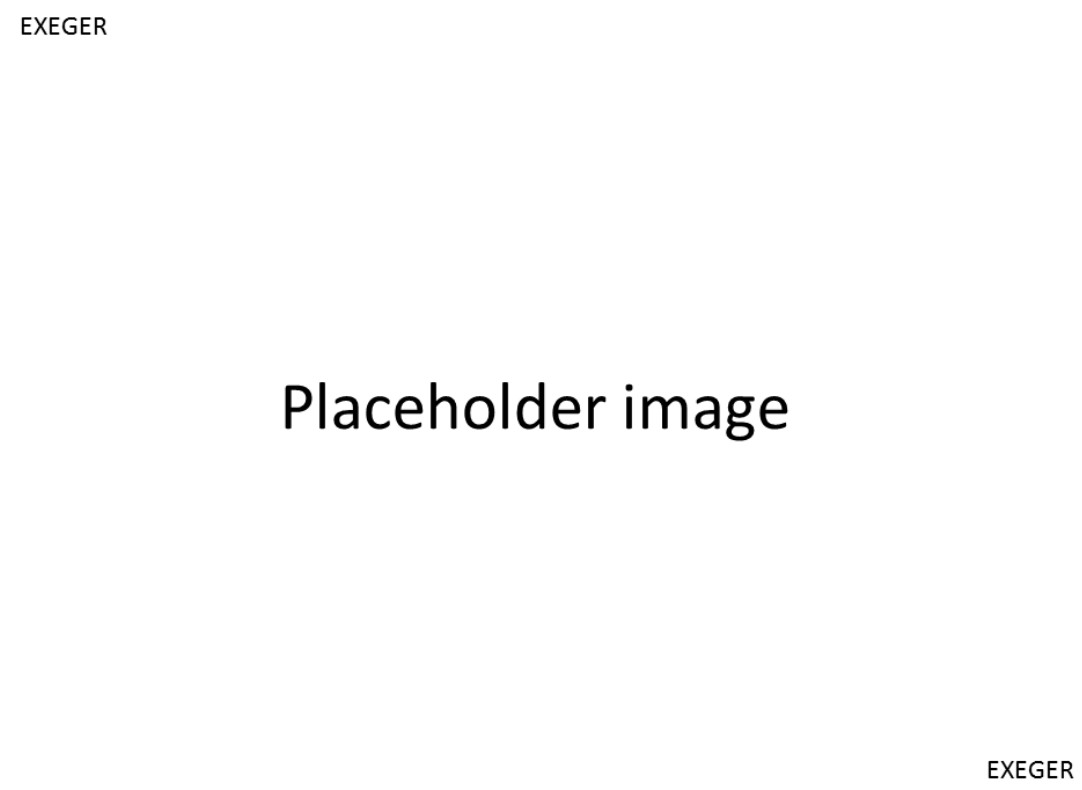

Figure 2.1: Perturb and Observe Method on implementation

2.2 INCREMENTAL CONDUCTANCE METHOD

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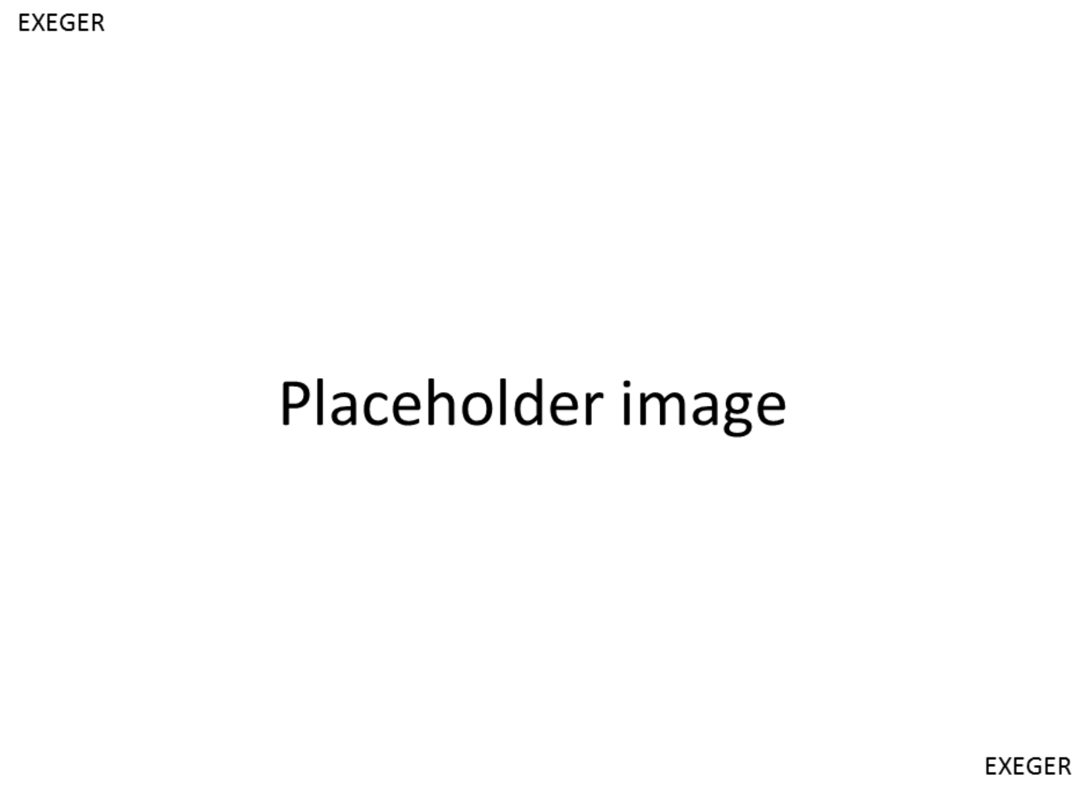

Figure 2.2: Incremental Conductance Method on implementation

2.3 FRACTIONAL OPEN CIRCUIT VOLTAGE METHOD

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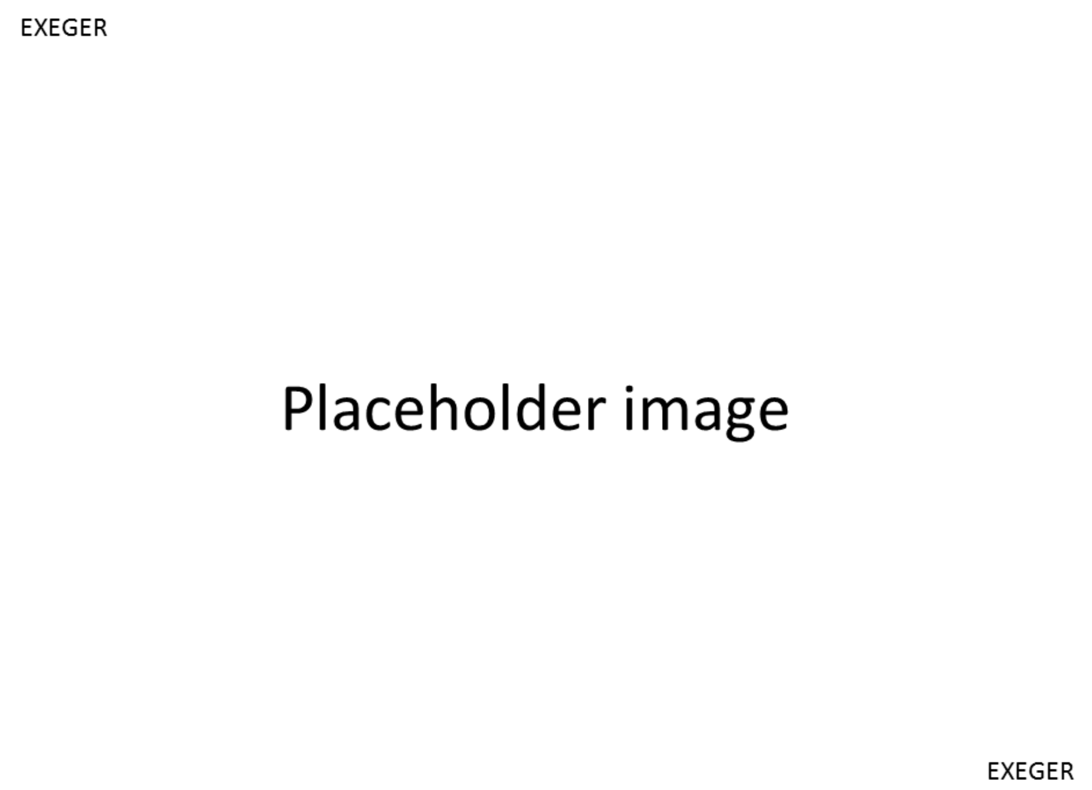

Figure 2.3: fractional open circuit voltage on implementation

2.4 PROPOSED METHOD

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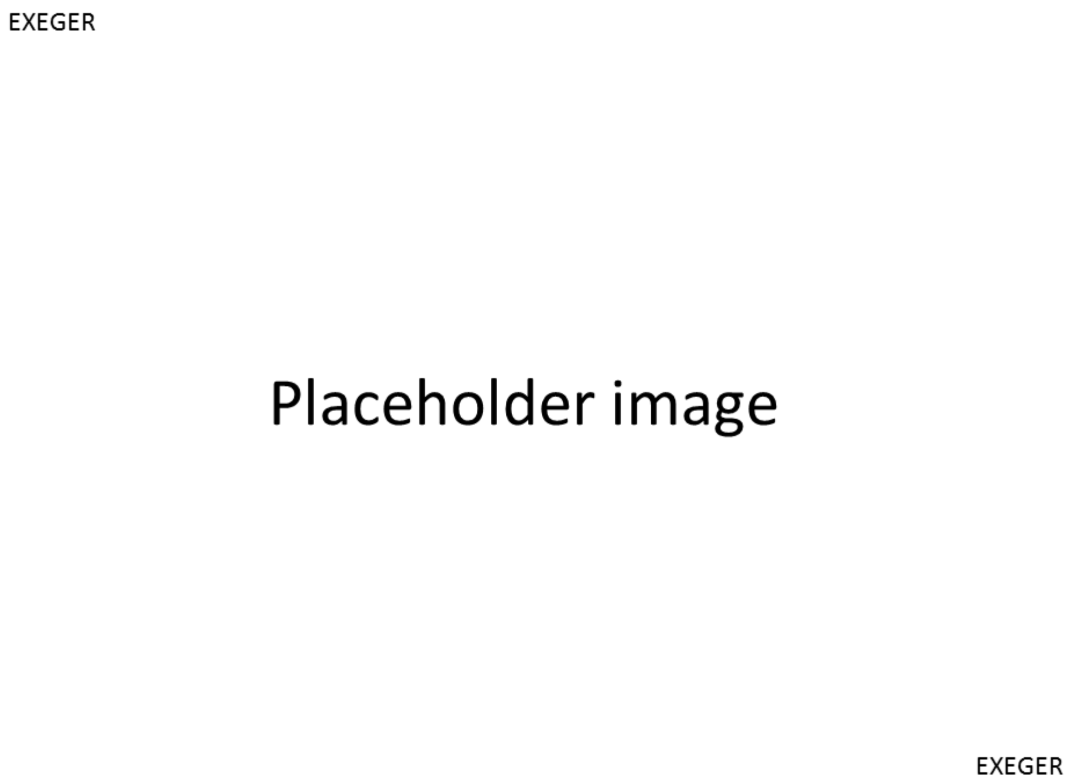

Figure 2.4: Flow chart for Proposed MPPT Algorithm

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