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A Fuzzy Adaptive Dynamic Model to reduce voltage Fluction in PV Control System

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ABSTRACT

One of the major renewable alternate power source is Photovoltaic solar. The solar energy is available in continously and unlimited amount. To utilize this energy, Photovoltaic Cells are used to convert this solar energy to electric energy. In this paper, a fuzzy adaptive dynamic model is defined to measure the temperate and capaistance of PV-model. Based on this measurement, the overvoltage condition can be identified and the voltage stability is achieved. The model is implemented in simulink environment. The dynamic model is defined to establish an integrated unit that reduced the voltage fluctuations.

Keywords: PV Cell, Voltage Stability, Simulic, PV Array.

1. INTRODUCTION

The energy sources are divided in two main categories. In first category, the energy sources that will be exhausted by exploiting them. Such energy source includes the nuclear energy, fossil fuels etc. These are main energy sources in these days and fulfill about 78% of power requirements. Another energy source category is the renewable energy sources that covers upto 22% over overall energy requirements. The solar energy, solar indirect energy etc. comes under this category. The solar energy is radiant energy produced by sun light. It is the renewable energy that is required to convert to electric energy. Some techniques are required to convert this solar energy to electric energy. The solar energy can be convereted to electric energy using some solar cell. PV-Cell is one such that which can be used to convert the solar energy to electric energy. This kind of solar cell are able to transfer certain amout of electrical power. The solar electricity cells can be connected to the solar panel called PV module. Using a PV module, larger amount of solar energy can be converted to electric energy. The solar cell is the basic unit in PV control system. These cells are able to produce the direct current and power. To understand the solar energy utilization, it is required to study the structure of PV cell and PV module. In this section, the elements of PV cells are defined.

Mounting structures:

The mounting structure on PV modules is formed to resist the network from local wnd forces.
When placed in a public area the structures should prevent stealing the modules. The further common requirements are not to cause shading of the modules and to be arranged so that there is an easy access to the modules for the maintenance or repair. The cost of the structures should be low. For integration in buildings, special mounting structures are being developed that together with the modules serve as building elements.

Energy storage:

The simplest means of electricity storage is to use the electric rechargeable batteries, especially when PV modules produce the DC current required for charging the batteries. Most of batteries used in PV systems are lead-acid batteries. The major difficulty with this form of storage is the relative high cost of the batteries and a large amount required for large-scale application.

Inverter:

The inverter's main functions are: transformation of DC electricity into AC, wave shaping of the output AC electricity, and regulation of the effective value of the output voltage. The most important features of an inverter for PV applications are its reliability and its efficiency characteristics. They are designed to operate a PV system continuously near its maximum power point. They deliver an AC output wave, which has a form very close to the pure sinusoidal one, with very little filtering at the output. This eliminates the bulky, expensive, and energy consuming power filters.

In this paper, a fuzzy adaptive model is defined to achieve the voltage statbility while converting the solar energy to electric energy. In this section, a brief description on PV control system is provided with associated elements. In section II, the work defined by earlier researchers is discussed. In section III, the proposed research methodology is presented. In section IV, the results obtained from the work are presented and discussed.

2. RELATED WORK

In this section, the work provided by the earlier researchers is discussed. Dale S.L. Dolan et al.[1] has defined a work to explore the development of PV panel in labview environment. The controlled environment based inherent variability was discussed by the author. The PV system was explored with inverters and MPPT algorithm specification. Author also discussed the variety of panels for effective utilization of power supply. Abu Tariq et al.[2] has defined a work on maximum power point tracking of PV panel. The work is defined to unload the PV panel and characterize it with specification of PV panel installation under the similar condition. The measurement are also defined to provide the open circuit voltage. The PV panel is never disconnected from load and the energy output based derivation was extracted from the system. Aime Lay-Ekuakille et al.[3] has defined an experimental setup on multiparameteric characterization of PV control system. The The development and utilization of energy was provided through prediction of energy requirement. The algorithm specific efficiency estimation and its dependency on different vectors including temperature, radiation was discussed by the author. T. L. Dragomir et al.[4] has provided the comparative analysis on various identification methods of PV cell characterization. The paper is concern on three methods with specification of different parameters associated to the models. The genetic algorithm with feature map was applied on different models.

T. L. Dragomir et al.[5] has defined a maximum power point determination for PV control system. Author characterize the external current and voltage to determine the maximum power point. Based on this feature, the transcendent algebraically system and non linear dynamic model. Francesco Adamo et al.[6] has characterize and test the PV panel model. The evaluation of performance under uncertainty was provided using PV model. The characterization of this panel was also predicted with behaviour specification. The validation of PV cell was formulated using some simulation tool.

Nicole C. Annis et al.[7] has presented the performance comparision on different modules of solar and thermal panels. The experimentation was provided to create the modular panel and also provide the maintainance of the system. Salman Sadiq et al.[8] has improvise the PV panel manufacturing solution for the cottage industry. The study was investigated with aimed approach at PV cell cost reduction. The electric supply through solar cell was regulated by the system. Author also defined a feasibility study on the manufacturing process for reducing the cost vector. Adrian Korodi et al.[9] has interpolative on the implementation of PV panel. An estimation on the maximum power point was provided through the interpolation method. The solution was defined using classical search methods methods against the probalematic issues. The environment condition analysis was also provided to observe the capability of solar system. Nalika N.B. Ulapane et al.[10] has extracted the parameters for effective simulation of Photovoltaic Panels. The PV modules were taken from the manufacturer with specific test and conditions. The estimation on these parameters awas provided with specification of diode cell model. The PV panel was defined to equalize the circuit with specification of entire solar panel.

Paula dos Santos et al.[11] has defined a relationship between the shading position and output power of PV panel. The research was defined to recognize the harmful effect of partial shading on PV control system. The paper has presented the study on electric model of solar cell. The computational evaluation was also provided to setup the relationship between the position of PV array and the electrical efficiency. Shozo Sekioka et al.[12] has presented an experimental study between the rod and PV cell. The experimentation was provided to characterize the gap between the PV control system. The occurance of surface discharge was identified by the author and presented it as a metallic plate. Ciprian Nemes et al.[13] has presented the Panel model based comparision between the analytical model. The accuracy specific model was defined to improve the accuracy of PV model The brief review on diode model was provided thorugh analytical equations. Mi-Seon Kang et al.[14] has presented a work to measure the multiple PV array. The paper is defined to describe the monitoring technology. The management of PV array was discussed by the author with usage and scalability features.

3. RESEARCH METHDOLOGY

Photovoltaic solar is one of the emerged renewable power source provides the effective alternative power source. Solar energy is one of the prospective energy that is available in unlimited amount and continuously. To fulfil the requirements of electric energy, the conversion of solar energy to electric energy is required. To perform this conversion, it is required to collect the solar energy and perform the conversion. One of the most used technologies for its harvesting is Photovoltaic Cells. These cell are smaller in size and useful in many small and portable applications. In this research, an effective model of photovoltaic cell and the panel. In this proposed model, the temperature sensing is been defined so that the voltage coefficient will be change and the capacitance of PV-model will be improved. The presented work will be able to handle the overvoltage and under voltage condition. The overvoltage condition will be handled by defining a saturation point so that the voltage control will be obtained. To handle the under voltage situation, the current gain will be stored using the constraint characterization and by performing the temperature sensing. In this work, a fuzzy adaptive approach is defined for constraint characterization with dynamic modeling to improve the gain vector and to improve the effectiveness of conversion process. The presented system will use the PV array that will connect multiple PV modules connected in a series. The presented model will be defined as the dynamic model that will utilize the current-gain as an integrated unit as well as it will reduce the voltage fluctuations.

A photovoltaic system gets the solar power as input and covert it to the electric form. This conversion is performed using PV cell. These cell can be used as individual component or can be group in the form of modules or the panel. These panels can further be group in the form of PV array to increase the system capability. A PV array is defined as the group of PV panels in which number of PV devices are connected. In this research, such kind of PV array system is defined and connected to the real time application. The application considered here is to process the induction motor. The work is able to provide the effective and controlled voltage to different DC motors and it provides the process to obtain the voltage and current specific to a load as well the control of power over the connected grid system is obtained so that the power consumption over the system will be reduced.

PV array is defined with the specification of I-V characteristics that itself represent different parameters based on which the adjustment to the system can be done. The equation form of PV cell is given here

$$I = I_{\mathrm{pv,cell}} - \underbrace{I_{0,\mathrm{cell}}\left[\exp\left(\frac{qV}{akT}\right) - 1\right]}_{I_{\mathrm{d}}}$$

Here Ipv,cell represents the current generated by incident light
Id represents diode equation,
I0,cell is saturation point or leakage current of diode,
q is defined as electron charge,
k is the constant value,
T is the temperature of PN junction
a is the diode constant

The basic form of the PV cell represents the IV characteristics that itself represents the array form of PV cell. The characteristic estimation over the cell is performed under different parameters defined in the equation itself. The figure form of this PV cell is shown in figure 1

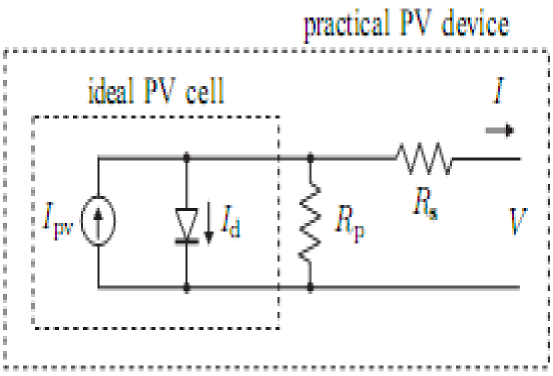

Figure 1: PV Cell Model

Figure 3.1 is showing the low level component of PV array. The PV cell is the device to convert the solar energy to electric energy. The dynamic control using fuzzy logic was provided to maintain the voltage stability.

4. RESULTS

The presented fuzzy integrated PV control system is impled in simulink environment. The control system is defined by integrating the PV module in the PV array. The block diagram of single PV module is shown in figure 2.

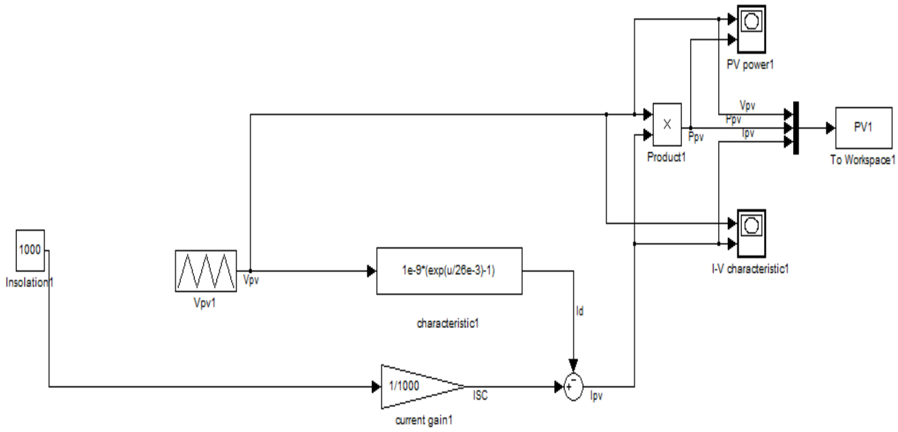

Figure 2: Single PV Module

Here figure 2 is showing the earlier stage of the PV module array based system. In this system, the single PV module is designed to obtain the current and votage gain. The system is showing the system has generated the I-V characteristics as final result.

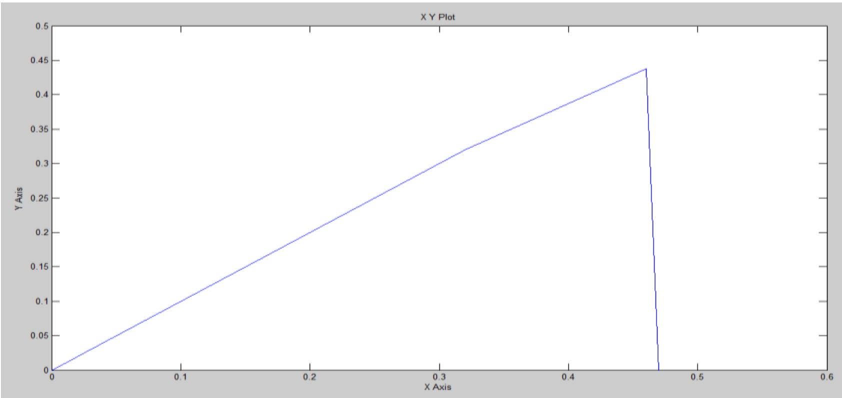

Figure 3: Result of IV System

Here figure 3 is showing the earlier stage of the PV module array based system. Here the results are obtained as IV system. Here the peak voltage is shown in the figure.

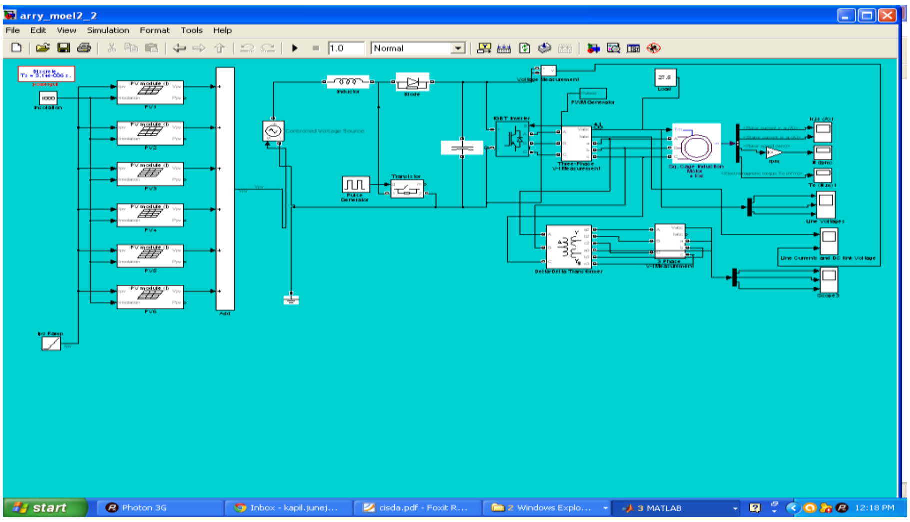

Figure 4: PV Module based PV Array System

Here figure 4 is showing proposed model in which the PV modules are connected in a series to generate the PV array module. The PV modules are integrated with individual voltage and current specification so that the current and voltage gain will be obtained. The voltage control mechanism is integrated in the system. Later on, the obtained voltage gain is converted to 3 phase system and it is integrated with induction motor.

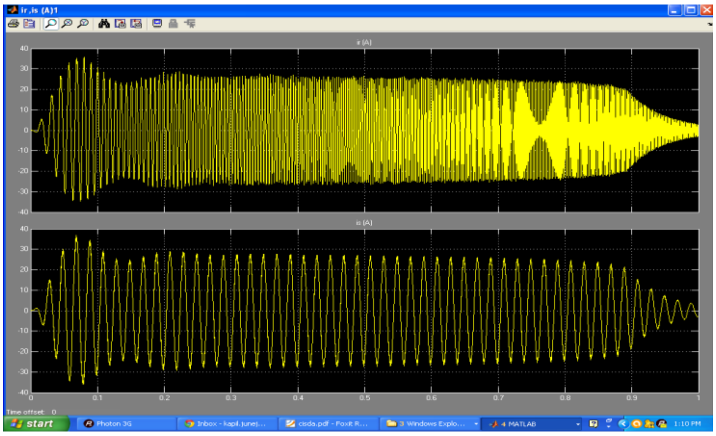

Figure 5: Voltage Stability

Here figure is showing the output of voltage stability in terms current and voltage value. The figure is showing the current values obtained here as final output are having lesser fluctuation and the overall signal stability is achieved here.

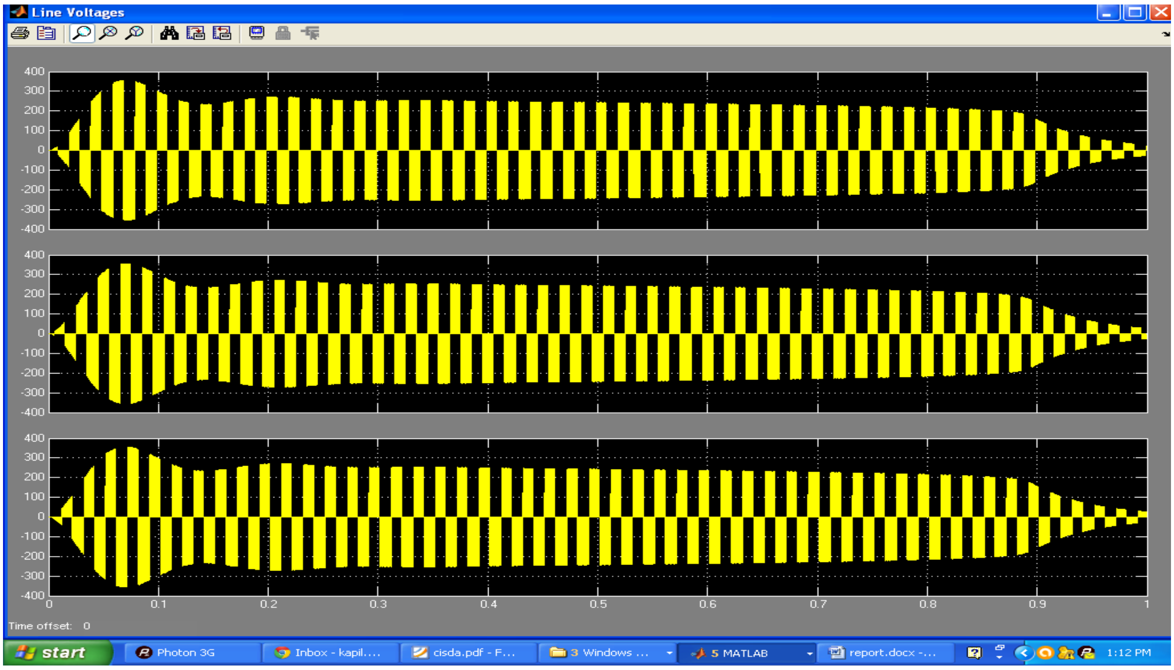

Figure 6: Line Voltage for 3 Phases

Here figure 8 is showing the line voltage for 3 diffrent phases. The figure is showing the stable voltage is been obtained for all three phases.

CONCLUSION AND FUTURE SCOPE

In this paper, a fuzzy integrated dynamic model is defined to utilize the current gain in an integrated environment for PV control system. The work is defined to obtain the current gain so that the voltage fluctuation over the system will be reduced. The induction motor is connected as the application to the system. To utilize the voltage in open environment, the conversion to the voltage is performed at three phases. The obtained results shows the voltage deviation to these three phases with linearly.

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