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Research Article

Design and Implementation of Maximum Point Power Tracking controller for Grid-connected Photovoltaic System and Analyzing its Performances

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ABSTRACT

The world is running fast and very competitive; in this world, the electricity plays a major role. To generate electricity, we have renewable and non-renewable resources. If we use non-renewable resources, it produces pollution and running cost of the plant is high when compared to renewable sources. In renewable resources, solar energy has great importance because it is easily available in worldwide for energy generation. However, only one drawback is efficiency and to increase its efficiency of maximum point power tracking (MPPT) techniques is used. Then, the solar has low efficiency. For improving efficiency and to make constant energy power generation, we are using MPPT techniques. The MPPT techniques used to track maximum point to produce constant power. Then, we are using converters to make the voltage level high. The converters are controlled by MPPT. According to the MPPT signal, the output of converter decides. Then, it is converted into ac using inverters to supply to the grid. In this paper, we are proposing incremental conductance MPPT algorithm for obtaining constant power and higher efficiency.

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INTRODUCTION

The need for renewable energy

Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat. These resources are renewable and can be naturally replenished. Therefore, for all practical purposes, these resources can be considered to be inexhaustible, unlike dwindling conventional fossil fuels. The global energy crunch has provided a renewed impetus to the growth and development of clean and renewable energy sources. Clean development mechanisms are being adopted by organizations all across the globe. Apart from the rapidly decreasing reserves of fossil fuels in the world, another major factor working against fossil fuels is the pollution associated with their combustion. Contrastingly, renewable energy sources are known to be much cleaner and produce energy without the harmful effects of pollution unlike their conventional counterparts.

Renewable energy trends across the globe

The current trend across developed economies tips the scale in favor of renewable energy. For the last 3 years, the continents of North America and Europe have embraced more renewable power capacity as compared to conventional power capacity. Renewables accounted for 60% of the newly installed power capacity in Europe in 2009 and nearly 20% of the annual power production.

As can be seen from Figure 1, wind and biomass occupy a major share of the current renewable energy consumption. Recent advancements in solar photovoltaic (PV) technology and constant incubation of projects in countries such as Germany and Spain have brought around tremendous growth in the solar PV.

Market as well, which is projected to surpass other renewable energy sources in the coming years. By 2009, more than 85 countries had some policy target to achieve a predetermined share of their power capacity through renewables. This was an increase from around 45 countries in 2005. Most of the targets are also very ambitious, landing in the range of 30–90% share of national production through renewable. Noteworthy, policies are the European Union's target of achieving 20% of total energy through renewable by 2020 and India's Jawaharlal Nehru Solar Mission, through which India plans to produce 20 GW solar energy by the year 2022.

Nowadays, the electricity is essential for the entire one. We have more demand in it; we need more power to run in this

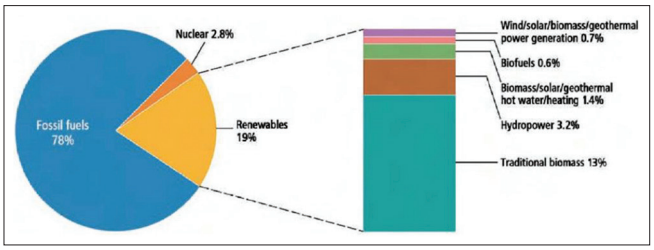

Figure 1: Global energy consumption in the year 2008

automated world. For generating electricity, we have renewable and non-renewable resources. The non-renewable resources are very expensive, pollute the atmosphere, and decreasing rapidly in the earth. The non-renewable sources plant running cost is high when compared to renewable resources plant. Hence, only we are preferring renewable resources. There are many renewable resources such as solar, wind, and gas. However, all the renewable resources are not easy to get from the earth in all the time. It may get from the earth for a season of times only. The solar plays a major role because it can be easy getting from the earth worldwide when compared to others.[1]

The fossil fuels are degrading in the earth nowadays. Hence, we are preferring renewable energy. The renewable energy cannot be placed in all the places. Due to this in reference paper 2 the author said about the optimization of renewable energy resources output. In optimization, we can see about which plant is suitable for which place and using this we can reduce the cost of the system. In renewable energy, the hydropower plant can place in water areas only, the wind can place in all the areas where the population is less, and the solar can place in every place. From this, only we consider wind and solar are the best. Its installation cost is but no need for fuel. So, no need of fuel and fuel transportation cost. In here, the wind can get for a season only, but the solar can place near to our come and solar energy can get all over the year. However, we can produce constant power in here. The solar panel or PV panel is a group of solar cell. The solar cell is made up of silicon, which can produce high voltage when compared to other materials. The silicon is just a semiconductor. The solar cell converts light energy into electrical energy. In here, the photons from the sunlight are hit in the silicon of the solar cell to produce power. The solar panel can place as any places easily. Using it, we can reduce the power generating cost.[3] In solar, we can generate power up to the efficiency of 30–40% and we cannot get constant power from it. In most of the places, we can place solar to generate power, but we are not using because of this drawback said in.[2] To improve this, we are preferring maximum point power tracking (MPPT) concept. From the name itself, we can determine that maximum power point (MPP) is going to be tracked. Using MPP of the system, we can produce constant power which may increase the efficiency of the system. Due to this, we can place solar in all the places.[4]

In MPPT, there are also many techniques which may be mostly used are,

- Perturb and observe (hill climbing method)
- Incremental conductance
- Fractional short circuit current
- Fractional open circuit voltage
- Fuzzy control
- Neural network control.

From the above techniques, some are not mostly used in most of the places due to its implementation cost and due to its complexity. Hence, the mostly used MPPT techniques are,

- Perturb and observe (hill climbing method)
- Incremental conductance.[5]

In,[6] the author uses perturb and observe MPPT technique in solar to track MPP value. It is also called as hill climbing method. It is the simplest method. In here, a single sensor is used to sense the PV array. The sensor may provide voltage sensor or current sensor. This method cost is low and easy to implement. The time complicity of the algorithm is very less. However, when the value gets closer to MPP, the MPP may not stop it flows in all the direction. When this occurs, we can find algorithm reaches MPP value. However, the algorithm cannot note the correct MPP value when there is a sudden change in the temperature and irradiation, and it shows the wrong MPP value.

In,[7] we can see the incremental conductance method used in PV system to produce constant power. The incremental conductance method is also used in most of the places which have great efficiency. In here, it has two sensors, one is voltage sensor and the other one is current sensor which is used for sensing the current and voltage of PV array. In incremental conductance, an equation is derived using slope of the PV array. In the equation, the left-hand side indicates the instantaneous conductance of the solar panel. When the instantaneous conductance is equal to the solar conductance the MPP reaches. In here, we are having both the voltage and current sensor which may work simultaneously. Due to this, it can work in sudden irradiation also.

However, the cost of implementation increases we use it for only highly complicated system. Due to this, only we are preferring the first two techniques only. In,[8] the author gives a comparison between the perturb and observe and incremental conductance method. The main drawback of the perturb and observe algorithm is when compared to the incremental conductance algorithm it has a single sensor due to this it cannot operate in sudden irradiation and temperature changes. In incremental conductance, it has two sensors. Hence, it can work in sudden irradiation and temperature changes. The cost incremental conductance is high when compared to perturb and observe, but the efficiency of perturb and observe is low when compared to incremental conductance. The converge speed is same in both the system. The periodic tuning is also same in both the system. Due to the sensing parameters, the incremental conductance leads the perturb and observe technique.

The boost converter is a type of direct current (DC)-DC converter. In this Paper the DC – DC converter is used to level up the voltage. It is also called as step-up converter. It is a class of switched mode power supply (SMPS) containing at least two semiconductors and at least one energy element storage such as capacitor and inductor. To reduce ripple, filters like capacitor are used in both sides of input and output. To overcome the SMPS, the boost converter is made. In here, the input current is continuous and output current is discontinuous. The output polarity is positive and the energy transfer is direct.[12]

The multilevel inverter is mainly used to convert DC voltage into alternating current (AC) voltage. It is just an electronic device. Using multilevel inverter, we can provide desired AC voltage level as output using the input as multi-lower level DC voltage. The multilevel inverter has low dv/dt. In here, more than two voltage levels are combined together to form output voltage. It produces low harmonics. In here, the smoothness of waveform is proportion to the voltage level. If we increase voltage level, the waveform becomes smoother but the components also increase and the more complex. There are three types of multilevel topologies,

- Cascaded H-bridge multilevel inverter
- Diode-clamped multilevel inverter
- Flying capacitor multilevel inverter.[13]

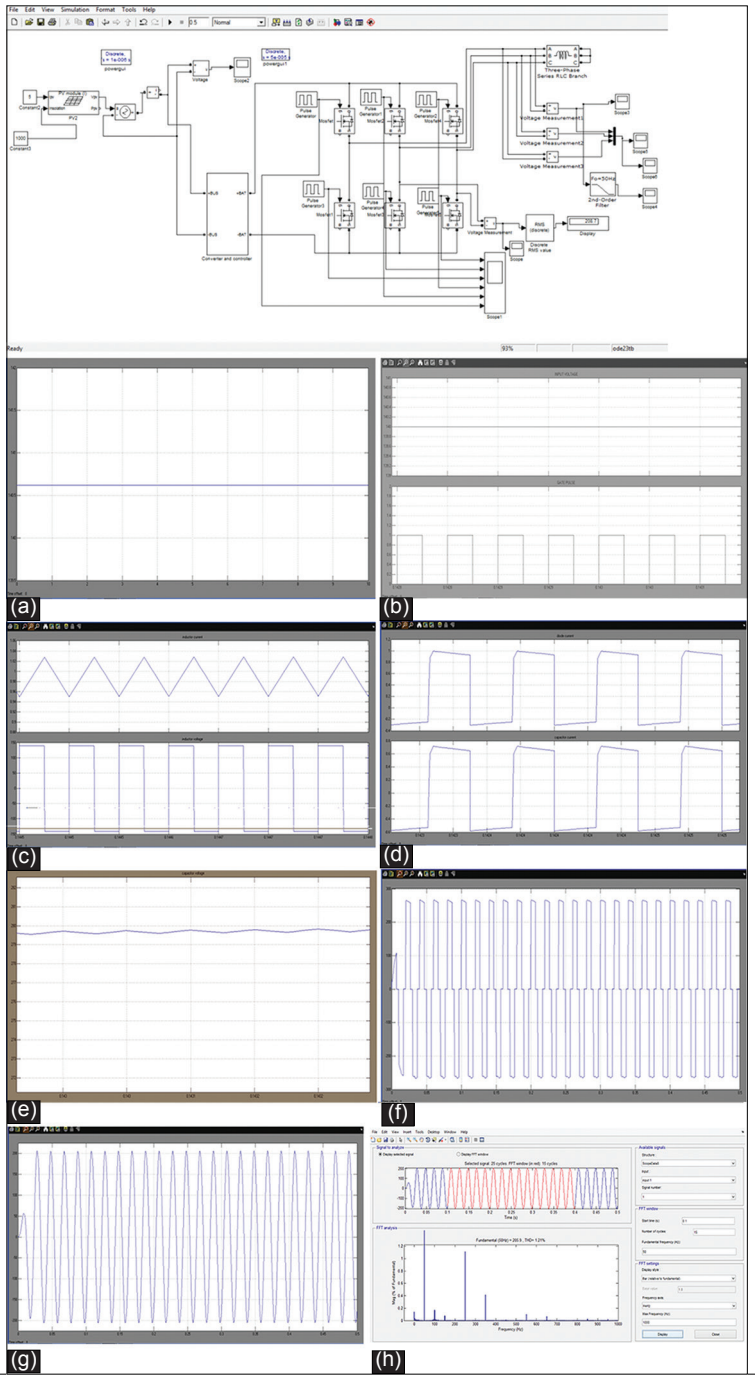

Figure **2:** Overall simulation for proposed system (a) Output of solar PV panel. (b) Input and gate pulse of boost converter. (c) Inductor current and inductor voltage of boost converter. (d) Diode current and capacitor current of boost converter. (e) Capacitor voltage of boost converter. (f) Output waveform of three-phase inverter. (g) Output waveform of three-phase inverter with second-order filter. (h) Fast Fourier transform analysis for three-phase inverter output voltage with second-order filter

Overall simulation for proposed system

Figure 2 shows the overall simulation for proposed system which consists of PV panel. The PV panel output is given to the boost converter. The boost converter is controlled by MPPT. Then, the boost converter output is connected to the three-phase inverter.

CONCLUSION

The paper proposes different MPPT algorithm and their differences, then which is the best simple MPPT algorithm is called incremental conductance method. This method computes the maximum power and controls directly the extracted power from the PV. The proposed method offers different advantages which are good tracking efficiency, response is high, and well control for the extracted power.

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