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Solar-powered tree with portable charging station and LED lighting

Megha Nerikar[1], Vishal Layankar[2], Apurva Walke[3]

Dimpal U. Zade[4]

Students of Electrical Engineering at Shri. Sai College of Engineering and Technology, Bhadrawati[1-3]

Assistant Professor in Electrical Engineering Deparatment at Shri. Sai College of Engineering and Technology, Bhadrawati[4]

Abstract: The energy requirement in the 21st century is substantially higher. We generate power using fossil fuels like coal and oil to meet this need. However, using these fuels leads to significant pollution, which has a negative impact on all living things. The use of fossil fuels will decline in 40–50 years. The main issue that will then develop is how to produce electricity, hence a solution to this issue is required. Using renewable energy sources to create electricity is one of the best answers to this issue. Sunlight is the most effective renewable energy source since it is both inexpensive and widely accessible in nature. We are able to produce pollution-free electricity by using solar panels. As electrical engineers, we are developing a new and simple technique for producing solar power called "solar tree." Traditional solar systems have a major drawback in that they take up more space. To address this issue, we suggest using solar trees, which produce more electricity while taking up less space. The spinning solar panels in our system, which can absorb an equal quantity of sunlight throughout the day, give it an edge over competing systems. In this case, mono-crystalline panels are used since they are more effective than other panels.

Keywords: Solar Tree, Design, Renewable Energy

I. INTRODUCTION

There is a rapid rise in population everywhere in the world. Energy consumption is higher than energy production. The primary energy sources are nuclear reactors and fossil fuels, however both of these are environmentally damaging and non-renewable. In compared to other kinds of renewable energy, solar power is the main alternative source and plays a significant part in maintaining a pollution-free environment. The best choice for producing pollution-free, long-lasting, and conveniently accessible power is solar energy. Solar panels are used to produce electricity utilizing solar energy. The conventional approach is still used for the majority of generating. Due to the conventional system's growing need for land and the difficulty in obtaining it due to the population's daily growth, a dilemma arises. A "SOLAR TREE" is the answer to this issue and can produce more energy from a smaller amount of land. An artificial tree with solar panels arranged in the Fibonacci sequence is known as a solar tree.

Why do we refer to them as solar trees? By way of photosynthesis, a natural tree makes its own nourishment. Similar to how leaves on a real tree produce food for people, solar panels on a solar tree also act as leaves, absorbing sunlight to generate energy for society.

T is stand for Generating Tree
R is stand for Renewable Source
E stands for electricity.
E stands for energy

Our system looks just like a tree. The tops of the tree's branches are where the solar panels are attached. This tree's topmost panel contains a tilting mechanism that rotates in response to the location of the sun. The topmost panel may produce an equal quantity of power throughout the day utilizing this tilting technique. Our method is more effective and efficient than the old one. It features a straightforward tree-like structure that is simple to setup for domestic usage. We can meet the need for energy consumption by establishing this system for daily usage. Therefore, this will be a fantastic approach for developing nations to generate clean energy.

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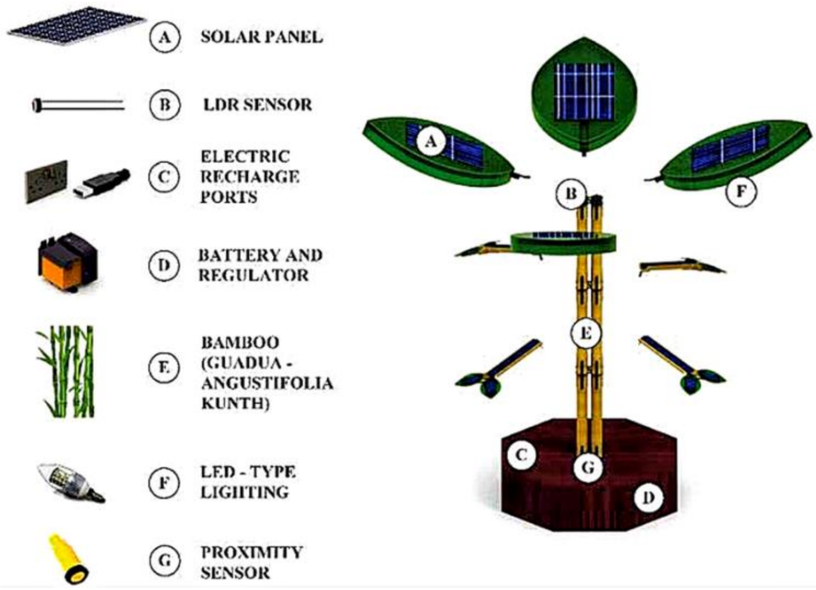

Fig. 1. Solar tree concept diagram

II. METHODOLOGY

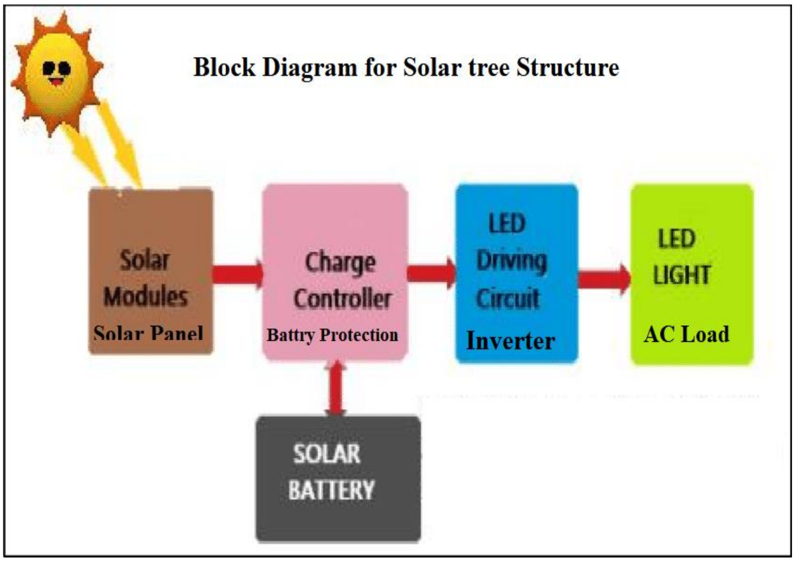

Fig. 2. Block diagram

2.1 Components Used

- 3 watt 6 Volt solar panel x 4
- Solar battery Charging Controller.
- 12 Volt DC to AC Inverter.
- Solar Tree Structure.
- PWM circuit
- IC CD4047
- IRFZ44 Power MOSFET – 2
- 12-0-12/1A Secondary Transformer
- 22KΩ Variable Resistor
- 100Ω/10W Resistors – 2
- 0.22µF Capacitors

2.1.1 Solar Panel

A PV panel, also known as a solar cell panel, solar electric panel, photo-voltaic (PV) module, PV panel, or solar panel, is an assembly of photovoltaic solar cells installed on a (often rectangular) frame. A photovoltaic system, also known as a solar array, is a neatly arranged collection of PV panels. Solar panels use the sun's radiation as a source of radiant energy, which is then transformed into direct current (DC) power. Solar electricity that directly powers electrical devices may be produced using photovoltaic arrays.

Fig. 3. Solar panel

With the help of the photovoltaic effect, photovoltaic modules, which are made up of several solar cells, may produce electricity. The majority of modules employ thin-film or wafer-based crystalline silicon cells. A module's top layer or rear layer may serve as its structural (load-bearing) part. It's important to shield cells from dampness and mechanical harm. The majority of modules are stiff, but there are also others that are semi-flexible and based on thin-film cells. Electrically, the cells are often linked in series, one to another, to get the necessary voltage, and then in parallel to boost current.

The module's power is measured in watts and is dependent on both the quantity of light and the electrical load that is connected to the module. Watts are calculated as the mathematical product of voltage and current. Solar panel manufacturing requirements are gathered under typical circumstances. The solar panel's output interface is a PV junction box that is fastened to its rear. The majority of photovoltaic modules' external connections make use of MC4 connectors enabling quick and simple weatherproof connections to the rest of the system. Another option is to utilize a USB power interface. In order to properly support the panel structure, solar panels also need metal frames made up of racking elements, brackets, reflector shapes, and troughs.

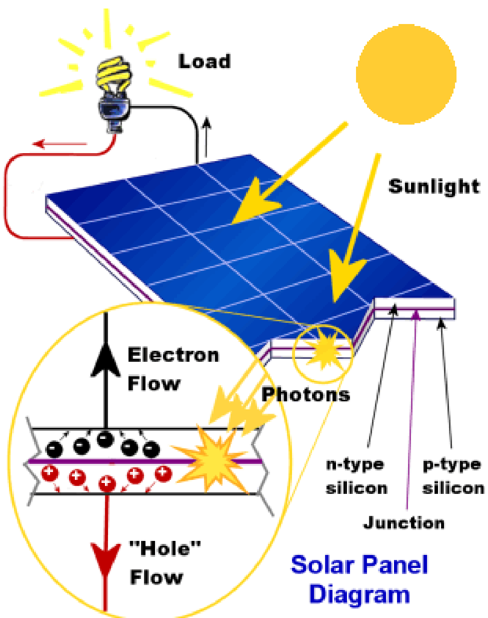

Fig. 4. Working of solar panel

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2.1.2 Solar Charging Controller

Although the intricacy of the control circuit changes based on the PV system, the fundamental idea remains the same. The graphic illustrates how the simplest solar charge and discharge controller operates.

PV module, battery, controller circuit, and load make up the system. The charging switch is Switch 1, while the discharging switch is Switch 2. When switch 1 is closed, the PV module charges the battery, and switch 1 also begins charging the battery again automatically in accordance with a pre-set protective mode. The battery powers the load when switch 2 is closed. Switch 2 may automatically restart power supply when the battery is recharged and reaches the pre-set resuming charging point.

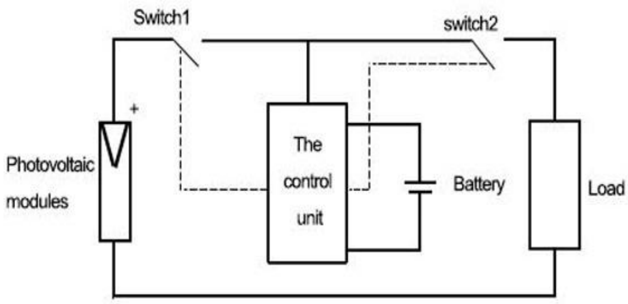

Fig. 5. Charging and Discharging System

2.1.3 Charging Controller Functions

Fig. depicts the parallel charge controller's basic circuit design. In order to address the power loss of the switching elements in the series charge controller, the switching elements of the parallel charge controller are connected in parallel at both ends of the PV module.

Switch from a PWM charging controller to a pulse mode When the battery tends to be fully charged, the PV module's terminal voltage steadily increases, the pulse frequency or duty cycle changes, shortening the on time, and the charging current gradually tends to zero. The charging current will progressively increase once again when the battery voltage has reached its maximum point of drop. This charging procedure can lengthen the battery's overall cycle life in the photovoltaic system and create a more complete state of charge. The battery's total cycle life in a photovoltaic system can be extended by pulse width modulation charging protection of the charging state.

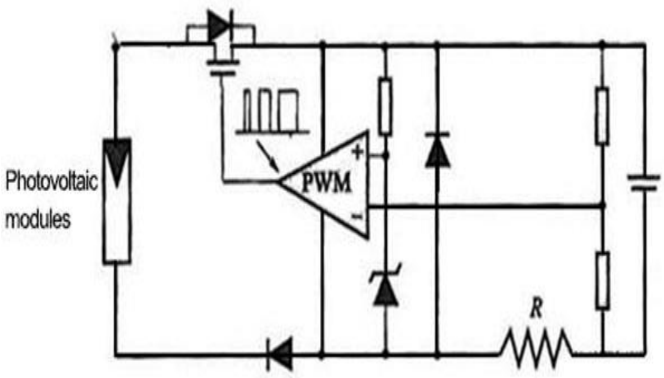

Fig. 5. Charging controller function system

2.1.4 12V DC to 220V AC Inverter Circuit

The article is about a simple, readily obtainable 12V DC to 220V AC inverter circuit. In locations where it is impossible to obtain an AC supply from the mains, inverters are frequently required. The DC electricity is transformed into AC power using an inverter circuit. When using a low voltage DC supply or battery to generate high voltage, inverter circuits are quite beneficial. It is also possible to utilize a DC-DC converter circuit, however it has some voltage restrictions.

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- **Components required for Inverter circuit.**

1. IC CD4047
2. IRFZ44 Power MOSFET – 2
3. 12-0-12/1A Secondary Transformer
4. 22KΩ Variable Resistor
5. 100Ω/10W Resistors – 2
6. 0.22µF Capacitors

Utilizing IC CD4047, the 12V DC to 220V AC inverter circuit was created. An oscillating switching pulse device is the IC CD4047. Switching is performed using the n-channel power MOSFET IRFZ44n. By converting low AC to high AC, the 12-0-12V secondary transformer is employed as a step-up transformer in the opposite direction.

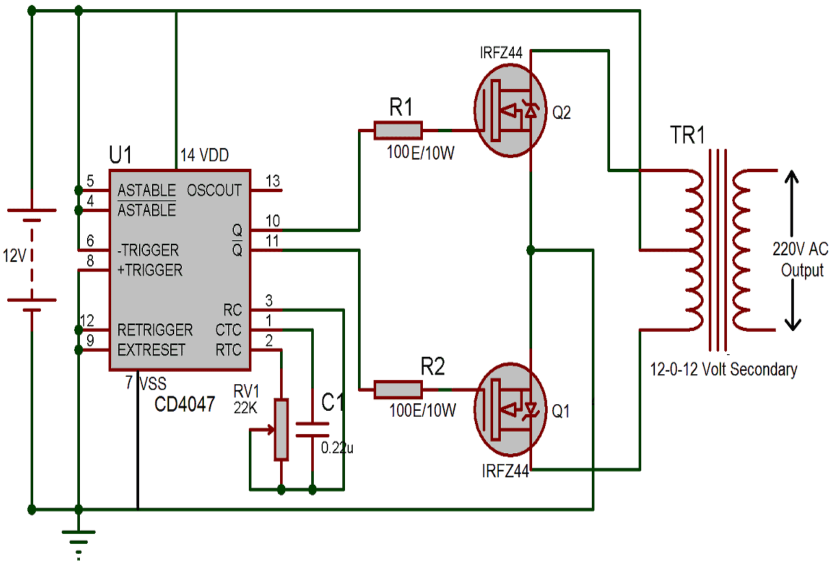

Fig. 6. Circuit diagram of 12V DC to 220V AC Inverter

With the aid of variable resistor RV1 and capacitor C1, the IC CD4047 is set up in astable multivibrator mode. We can change the value of RV1 to obtain a varied output pulse range at CD4047's Q and Q' pins. As a result, there is a variance in the transformer's output voltage.

The secondary pins of the transformer are linked to the drain pins of the n-channel power MOSFETs IRFZ44, and the common pin in the secondary winding is connected to the positive terminal of the battery. The negative terminal of the battery is linked to both of the MOSFET source pins. The MOSFET turns ON when the alternate square pulse from Q & Q' drives it. The secondary winding is then made to generate a different magnetic field. High alternate voltage of about 220V is produced by the magnetic field that is induced.

Circuitry produces 220 AC voltage, which is supplied to electrical outlets and on/off switches.

2.1.5 Lead-Acid Battery Function

Lead and sulfuric acid are used to power a rechargeable 12 Volt 7.2 AH lead-acid battery. To enable a regulated chemical reaction, the lead is immersed in sulfuric acid. Electricity is generated by the battery as a result of this chemical process. Then, to recharge the battery, this reaction is reversed.

Simply put, the sulphate in the sulfuric acid bonds to the lead to produce the electrical charge in the battery. Reversing this process will recharge the electrical charge. In other words, the sulphate reacts with sulfuric acid once more to recharge the battery. Of course, the sulphate ions in the acid are limited in number. Additionally, there is a finite amount of surface area on the lead it attaches to. Therefore, the charge weakens as the sulphate is consumed. Because of this, lead-acid batteries are not recommended for continuously operating electronics. Instead, they work best for applications that require a quick burst of strength in energy.

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Fig. 7. Lead Acid Battery

Fig. 8. Solar tree structure

III. ADVANTAGES

- zero air pollution.
- Future energy sources wouldn't be a major concern for us.
- Even in a developing nation, people would have access to power.
- People are able to decrease costs.
- Very little land is needed.
- Electrical bill decreased.
- Easy to maintain.

IV. DISADVANTAGES

- capital Cost is prohibitively costly.
- may put birds and flying creatures in threat.
- Consequences from solar reflectors affecting one's eyesight

V. APPLICATION

- Many different businesses, factories, offices, schools, etc. When the land is managed properly, they can be installed.
- Solar trees can help residential areas like colonies.
- They can be put in place to power security cameras and lighting systems on motorways.
- Both highways and coastlines can use them.
- They can be erected in public areas such as parks, gardens, tourist destinations, etc. to power lighting and improve visual appeal.

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VI. FUTURE SCOPE

A more cost-effective way to utilize solar energy is through solar-generated electricity. In 2010, solar energy made significant advancements. The world market was very tiny and reliant on subsidies from a small number of nations. The most affordable method of creating new electricity is now solar energy.

It can be made extendable as necessary. It can be utilized for free as an electric vehicle charging station.

VII. CONCLUSION

The solar tree appears to be the ideal answer to our energy demands in the future. A ground-breaking idea for urban illumination, the solar tree perfectly combines avant-garde style with cutting-edge eco-friendly technology. The tree design produced 50% more electricity and increased sunshine capture by up to 50%. You can have them on your homes, they're cheap to use, they save money, and they're good for the environment. It is free, environmentally friendly, and lasts forever.

The solar tree concept is very effective and should be adopted in India to supply electricity without the problem of power cuts and the additional energy may be delivered to the grid in order to meet the rising energy demand of the people while saving land. Given that India has a large population, we should utilize energy sources that demand very little land to produce energy effectively. The solar tree may be our greatest option in this situation. In terms of area and efficiency, it is both superior than the conventional solar PV system and considerably more effective. Therefore, this will be a great alternative and should be put into practice. Additionally, solar-powered trees are a non-traditional method of electricity production with a number of advantages over other sources.

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