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Solar Inverter with Wireless Home Automation System

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ABSTRACT

Increasing energy demand, high oil prices and concerns about environmental impacts are driving the development of renewable energies such as wind, solar, sea, biomass and geothermal. Solar energy is one among the foremost developed renewable energy sources . In our project, we will create a solar inverter that converts solar energy into electrical energy. This energy is used to charge the battery and simultaneously power the home lightning system and the sockets that charge multiple appliances. Home lightning systems that consist of Arduino circuits that help enable wireless operation.

Keywords: *Solar Energy , Inverter , Photovoltaic Cells , Wireless Operations*

1. INTRODUCTION

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of conventional and polluting fossil fuels have to be investigated. One such substitute is solar power .Solar energy is sort of simply the energy produced directly by the sun and picked up somewhere else, normally the world[1] . The sun generates its energy through a thermonuclear process that converts about 650,000,0001tons of hydrogen to helium every second. The process creates heat and electromagnetic waves .Only a really small fraction of the entire radiation produced reaches the world . The radiation that does reach the Earth is the indirect origin of nearly every type of energy used nowadays. The anomalies are geothermal energy, and nuclear fission and fusion. Even fossil fuels owe their origins to the sun; they were once living plants and animals whose life was reliant upon the sun.[2]

Renewable energy sources such as solar, geothermal, biomass, and wind have become significant contributors to global energy consumption.These alternate energy sources will never run out. They produce fewer emissions. As a result, they stand out as a potentially viable source of pure, infinite energy. These resources do not pollute the environment in any substantial way with significant health risks, and they appear to be abundant natural resources. Solar energy is one of the most rapidly developing renewable resources.The goal of this project is to create a solar inverter that can control home lighting by using a bluetooth module.Solar energy is converted to electrical energy by photovoltaic(PV) cells. This energy is stored in batteries for utilization purposes for operating several domestic appliances.A solar inverter, or PV inverter, converts the direct current(DC) output of aphotovoltaic solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a Local, offline electrical network. As an extended application of this project we have developed a home automation system consisting of an Arduino based circuit which enables the smooth functioning of wireless home appliances[11].The automation control gadget in the project is the Arduino UNO.The Arduino UNO reads the data and decides the switching action of the electrical gadgets connected to it through the relay.[10]

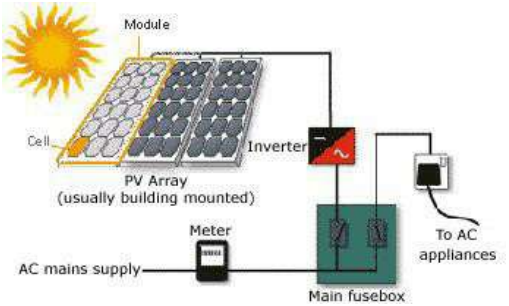

Figure 1 : Overview of Solar Inverter

2. SCOPE AND OBJECTIVE

The main objective of our project is to design and construct a PV based system that produces electric energy and operates in dual mode, supplying stand-alone AC loads, while reducing its cost and size. With the growing cost of electricity and concern for the environmental impact of fossil fuels, implementation of eco-friendly energy sources like solar power are rising. The system's

main property is production of quality electricity from a renewable source to reduce dependence on fossil fuels and the associated emissions of pollutants. Our goal is to design and develop an inverter that will operate the task described. In addition to this we have also developed a home automation system using Arduino and bluetooth module. As automation is the most repeatedly spelled term in the field of electronics. The hunger for automation brought many revolutions in the existing technologies. These had significant importance than any other technologies due to its user friendly nature. These can be used as a replacement of the existing switches in home which creates sparks and also results in fire accidents in few situations. Considering the advantage of bluetooth an advanced automation system was developed to control the appliances in the house.The goal of this project is to develop a home automation system that gives the user complete control over all remotely controllable aspects of his or her home.Th projects aim at designing an advanced home automation system using normal web server and bluetooth technology.The devices can be switched ON/OFF and sensors can be read using a personal phone using bluetooth.[4]

3. SYSTEM DESCRIPTION

Its main function is to convert direct current into alternating current generated by a solar generator. It allows monitoring of the system so that the people who operate the system can see how the system works. If you are considering a solar panel system for your home, one of the key decisions you make is what type of inverter to install. The inverter converts the direct current (DC) power generated by the solar panels into usable alternating current (AC) electricity. After the solar panel, the inverter is the most important device in the solar power system.

In this work, two Arduino Integrated Development Environment (IDE) software and a Bluetooth terminal application are used. This section describes Arduino programming and Android application development. The microcontroller is programmed in C using the Arduino IDE. Android apps are developed using Java and appear as GUIs in mobile phones. The Arduino programming code is executed using the Arduino IDE compiler. The code is injected into the hardware using a USB cable. Android applications are used to connect between devices and home appliances. In this article, we demonstrated the design and implementation of a wireless, flexible, and low-cost solution for home automation. The system is secure for any user to access. Users need to get a pairing password for Arduino BT and mobile phone to access home appliances. This adds protection against unauthorized users. This system can be used as a test bed for all devices that require on-off applications without any internet connection.

4. RESEARCH METHODOLOGY

A solar inverter works by taking in the variable direct current, or 'DC' output, from your solar panels and converting it into alternating current, or 'AC' output. Solar panel converts the light energy from the sun rays into electrical energy with the help of photovoltaic cells.The electrical energy generated from the solar panel as an output is, in DC form. Further this electrical energy is stored in the battery. Hence a DC to AC Inverter circuit is used to convert DC form of electricity into AC form. Then this low voltage AC output is passed to the transformer. Transformer steps up the AC voltage which we can use in any domestic appliances or in any electrical grid. This supply can also be used for mobile charging, or any small scale purposes.

The electricity which is stored in the battery is used in the Arduino circuit. The Arduino circuit is connected with a battery for home automation. A bluetooth android application is connected with an arduino circuit through a bluetooth module. Arduino is further connected with relays which isfollowed by bulb holders connected to each relay. Command is given to the Arduino circuit through the bluetooth module from android application. Arduino controls the ON/OFF function of the bulb as per the given command from the android application. An external supply is required for the functioning of relays.

Concepts used in designing of solar inverter

There are many topologies or circuit designs for creating higher power AC from low voltage DC sources. Two common topologies are the Push-Pull and H-Bridge. The Push-Pull topology is suitable for producing square and modified square wave inverters while the H-Bridge is useful for producing modified square wave and sine wave inverters.

Figure 5 : working layout of solar inverter

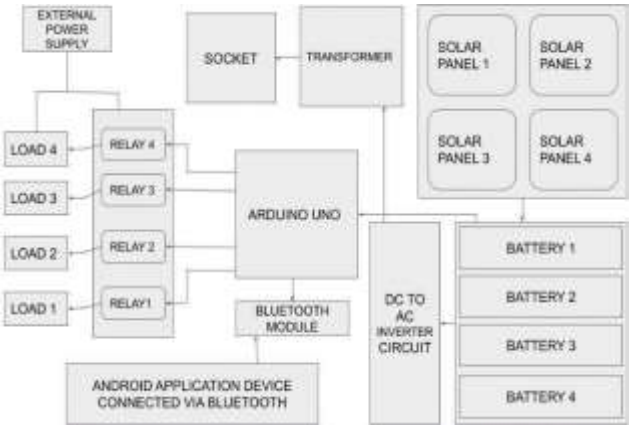

Figure 4 : Schematic Layout

5. DESIGN PROCEDURE FOR SOLAR INVERTER

Solar inverters work by taking a variable DC or "DC" output from a solar panel and converting it to an AC or "AC" output. Solar panels convert the light energy of the sun's rays into electrical energy with the help of solar cells. The electrical energy generated by the solar panel as an output is in DC format. In addition, this electrical energy is stored in the battery. Therefore, a DC to AC inverter circuit is used to convert DC format electricity to AC format. This low voltage AC output is then sent to the transformer. Transformers increase the AC voltage that can be used in household appliances and any power grid. This power supply can also be used for mobile charging and small purposes. [6,7]

Designing a PV system can be done in four steps:

1) Determining power demand

A load is one that consumes power. The first step in planning a PV system is to determine the total power and energy consumption of all loads that need to be powered by the PV system.

2) Inverter sizing

Inverters are used in systems that require AC output. The input power of the inverter cannot be lower than the total wattage of the device. The inverter must have the same nominal voltage as the battery. For stand-alone systems, the inverter should be large enough to handle the total wattage used at one time. The size of the inverter should be 25to30% larger than the total capacity of the device

3) Battery size

The recommended battery type for use in solar systems is the deep cycle battery. Deep cycle batteries are specially designed to discharge to low energy levels and quickly recharge, or to charge and discharge daily for years. The battery should be large enough to store enough energy to run the device at night or on cloudy days

4) Number of PV modules required

Determine the number of PV modules you need based on the size of the PV modules.

6. MAIN COMPONENTS OF SOLAR INVERTER AND HOME AUTOMATION SYSTEM

6.1 Solar Panel

A solar panel (also solar module, photovoltaic module or photovoltaic panel) is a collection, connected assembly of solar cells, also known as photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to create and supply electricity in commercial and residential applications. Because a solo solar panel can produce only a limited amount of power, many installations contain several panels. A photovoltaic system typically consists of an array of solar panels, an inverter, and sometimes a battery and interconnection wiring.

Figure 7.1 : Solar Panel

6.2 Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328P.

1) It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog feed in, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a recalibrate switch.

2) Simply connect it to a laptop with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Figure 7.2 : Arduino UNO

6.3 Bluetooth Module (HC-05)

1) For the communication between a mobile phone and a microcontroller Bluetooth module(HC-05) is used.

2) HC-05 is a low power 1.8V operation and is easy to use with Bluetooth SPP (serial port protocol).

3) Serial port Bluetooth modules have a Bluetooth 2.0+EDR (enhanced data rate), 3Mbps modulation with complete 2.4GHZ radio transceiver and baseband.

4) Using Bluetooth profile and android platform architecture different types of Bluetooth applications can be developed.

Figure 7.3 : Bluetooth module(HC-05)

6.4 Relay

1) Relay is basically an electromagnetic switch which can be turned on and off by applying the voltage across its contacts.

2) This project used a 12V 4-channel relay.

Figure 7.4 : working layout of solar inverter

TRANSFORMER

A transformer is an electrical device and it consists of 2 windings connected by an iron core. It provides the much-needed ability to simply change current and voltage levels. The main function of a transformer is to increase (hiccups) or decrease (hiccups) the AC voltage. Transformer works based on the principle of Faraday's law of electromagnetic induction, that is, mutual inductance occurs between two circuits connected by a common magnetic flux. A transformer that converts electrical power from one circuit to another} with the help of mutual induction between 2 windings that have no electrical connection between them, and at the same time transforms power from this circuit to another circuit} without changing the frequency but with a different voltage level. In an upgraded transformer, the secondary winding contains more windings than the first. Going back to the transformer, it has more windings in the primary than in the secondary. This is one of the main reasons why we use AC in our homes and not DC. The DC voltage cannot be changed using a transformer.

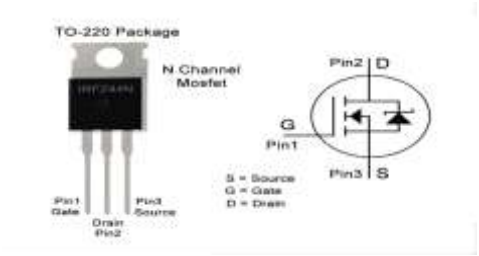

Figure 7.6 : Mosfet

7. FUTURE SCOPE

As the whole world is facing a problem of global warming and energy crisis, our project will help to reduce these problems by using solar energy to generate electricity. Main motto of our project is to encourage use of renewable energy sources. This project is most useful in our life because in this project one time investment is fixed on lifetime. In the future one day conventional sources of energy will end, then we will use renewable energy. The solar inverter made by us is just a prototype for making future projects which integrate advanced technologies like micro controlled solar tracking, charge control, etc. this is to show that solar inverters are very economical and easy to install so that the energy demands are shifted on using renewable sources of energy. There are more advancements pending in this field which will revolutionize the energy stream and solar energy will be playing the most important role of all. Memory can be used to store the appliance status during power failure. Appliance scheduler/timer can be implemented using RTC (Real Time Clock) Can be changed to an IoT device using Bluetooth connectivity.[5]

7.6 MOSFET

Figure 7.5 : Transformer

8. BENEFITS

1) Integrate with automatic indoor/outdoor lighting systems.
2) Intelligent decision support system for overall operational control.
3) Drip irrigation system / automatic garden management. MOSFETs (metal oxide-semiconductor field-effect transistors) are a type of special field-effect transistors (FETs) that operate by electronically varying the width of the channel through which charge carriers (electrons) travel. The wider the channel, the better the device moves. The charge carriers enter the channel at the source and exit through the drain. The width of the channel is controlled by the voltage across an electrode called a gate, which is placed within the source and drain and is outlied from the channel by an extremely fine layer of metal oxide.
4) The APSS mechanism ensures maximum use of solar energy.
5) Maximize the use of solar energy with IoT.
6) Integrate with automatic indoor/outdoor lighting systems.
7) Intelligent decision support system for overall operational control.
8) Drip irrigation system / automatic garden management.
9) The APSS mechanism ensures maximum use of solar energy.
10) Cloud-connected remote smart switch/wireless socket

9. CONCLUSION

Photovoltaic power generation is becoming important as a renewable energy source due to its many advantages. These benefits include a permanent power generation system that is pollution-free, easy to maintain, and converts sunlight directly into electricity. However, the high cost of PV installation remains an obstacle for this technology. In addition, PV panel output power fluctuates depending on weather conditions, such as insulation level and temperature of the cells. The project is described as valuable because of the promising potential it holds, ranging from long-term economic benefits to significant environmental benefits. This work will mark one of the rare efforts and contributions in the Arab world, in the field of renewable energy; where such projects can be widely implemented. With ever-increasing improvements in energy electronics and solar cell technology, such projects will add more value and need more attention and support. Therefore, we can conclude that the required goals and objectives of the solar inverter home automation system have been achieved.

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