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Hybrid power generation using dual axis solar tracking system and wind energy system

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ABSTRACT

Solar and wind are two renewable means of energy sources that are now gaining attention widely for production of electricity. Global energy demand has been continuously increasing over the last century. Solar and wind energy are available in large amount. To enhance the efficiency of the solar system, the paper deals with dual axis solar tracking system. Proposed plan can be used for rural electrification and modernization of remote areas.

Keywords: *Solar energy, Wind energy, Dual-axis tracking, Hybrid system*

1. INTRODUCTION

Conventional energy sources are being depleted day by day and the cost of power production and usage is increasing at a fast rate. By using the microcontroller atmega328 we can control the solar panel to achieve the mission of dual axis tracking. The output of PV cell directly depends on the intensity of light falling on it. Absorption efficiency of immobile and single axis panels are significantly less at certain times of day and year. Hybrid energy systems are expected to grow tremendously in the near future. A number of hybrid energy systems in use are undergoing tests in various parts of the world. Design of a hybrid energy system is site specific and it depends upon the resources available and the load demand.

Solar energy and wind energy are two renewable energy sources that can be effectively combined to produce electrical power by photovoltaic and wind turbines respectively. Hybrid solar and wind systems of several sizes have been developed and interesting results have been extracted from installations of these compound systems.

2. LITERATURE REVIEW

A number of papers published in IEEE journals and conferences were reviewed. The literature discussed reliability in renewable energy generation, dual axis tracking and role of electronics have been highlighted.

Recently solar, wind power generation has attracted special interest; the rapid growth of wind power worldwide has resulted in increased media attention and public awareness of wind generation technology. PV output is dc and then converted to ac by inverter [1]. Design and construction of an inexpensive active dual-axis solar tracking system for tracking the movement of the sun so as to get maximum power from the solar panels are possible. We can use Light Dependent Resistors to sense the position of the sun which is communicated to an Arduino Uno microcontroller which then commands a set of two servo-motors to re-orient the panel in order to stay perpendicular to the sun rays [2]. In [3] main trends of the power electronics used in applications of the wind turbine technology are presented. Due to the high demand for renewable energy sources applications, there is a continuing research for improving the total efficiency of these applications. The development of modern power electronics has been briefly reviewed, showing that the wind turbine behavior/performance is very much improved by using power electronics.

In the active tracking system; the sun's position during the day is continuously determined by feedback sensors [4]. The sensors will trigger motor/actuator; which will, in turn, cause the movement of the mounting system so that the solar panels will always be perpendicular to the sun throughout the day. The drawback of such a system is that it is very sensitive to certain atmospheric conditions and might not be able to continue tracking the sun on a cloudy day. One of the most important factors behind the selection of a tracking system is cost. Active tracking systems; even though popular; are expensive and add on to the capital cost of installing a solar PV system.

3. BLOCK DIAGRAM

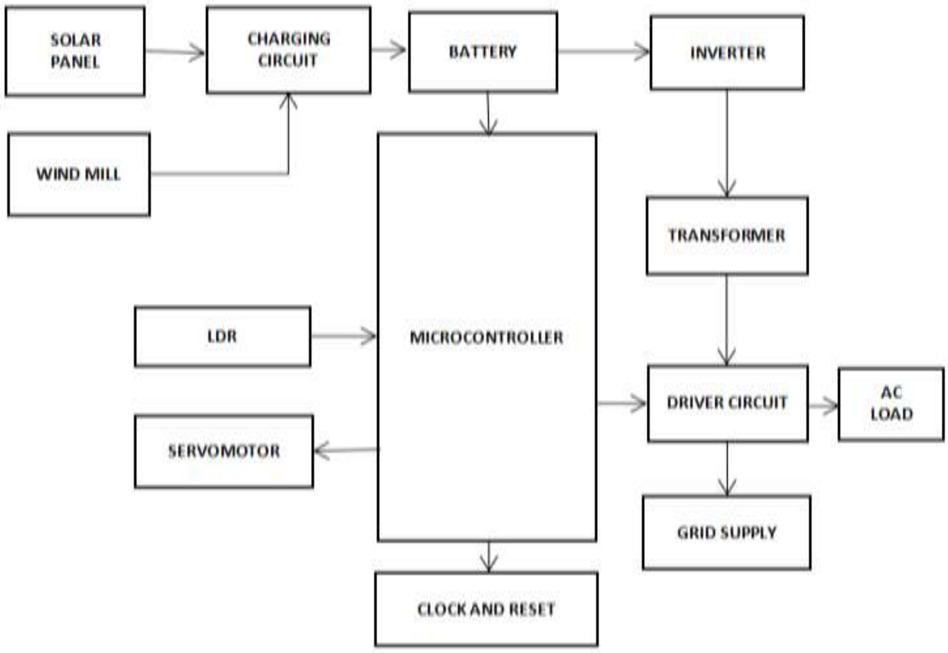

Fig. 1: Block Diagram

3.1 Block diagram description

Microcontroller: The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Here we need two microcontrollers. One for controlling the solar panel (dual axis tracking) and another for controlling the relay.

Solar panel: Movement of solar panel is controlled by two servomotors. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W). Here we used a module of 48 cells which can produce 14V.

Windmill: We can take advantage of DC geared motor to demonstrate windmill. DC motor coupled with a gearbox is called DC geared motor. A gear motor adds mechanical gears to alter the speed/torque of the motor for an application. Usually, such an addition is to reduce speed and increase torque. 14 V DC geared motor is utilized here.

Charging circuit: Output of solar and wind systems are compared using a comparator. The battery charger is operated on the principle that the charge control circuit will produce the constant voltage. The output voltage and current are regulated by adjusting the adjust pin of the LM317 voltage regulator, which is incorporated in the charging circuit. The battery is charged using the same current.

Battery: A 12V, 1.5Ah battery can be used. The battery type recommended for using in solar PV system is deep cycle battery. Deep cycle battery is specifically designed to be discharged to low energy level and rapid recharged or cycle charged and discharged day after day for years. The battery should be large enough to store sufficient energy to operate the appliances at night and cloudy days.

Light Dependent Resistors (LDR): LDR sensor module is used to detect the intensity of light. It is associated with both analog output pin and digital output pin labeled as AO and DO respectively on the board. When there is light, the resistance of LDR will become low according to the intensity of light. The greater the intensity of light, the lower the resistance of LDR. The sensor has a potentiometer knob that can be adjusted to change the sensitivity of LDR towards the light.

Servomotor: Servo motors are great devices that can turn to a specified position. Usually, they have a servo arm that can turn 180 degrees. Using the Arduino, we can tell a servo to go to a specified position and it will go there. Servomotors are connected with the analog pins of the microcontroller.

Inverter: Single level inverter is used to convert the DC to AC. The power of a battery is converted in to' main voltages' or AC power. This power can be used for electronic appliances like television, mobile phones, computer etc. The main function of the inverter is to convert DC to AC.

Transformer: Transformers convert AC electricity from one voltage to another with a little loss of power. Step-up transformers increase voltage. Here we use a center tapped step-up transformer. The output voltage of the transformer will be 230 V.

AC load: Any low power load can be run using the setup since the design and construction is of project level.

4. METHODOLOGY

The main component is Arduino Uno; single-board microcontroller. It has an open-source physical computing platform and a development environment for writing software for the board and is inexpensive. The other main components are Light Dependent Resistors (LDR's); servo -motors; solar panel. Figure 1 depicts the methodology adopted. The solar tracking system is done by Light Dependent Resistor (LDR). Four LDR is connected to Arduino analog pin AO to A4 that acts as the input for the system. The analog value of LDR is converted into digital (Pulse Width Modulation) using the built-in Analog-to-Digital Converter.

The values of PWM pulse are applied to move the servos. Two servomotors are required. One is placed horizontally and the other is placed vertically. The maximum light intensity captured by one of the LDR's input will be selected and the servo motor will move the solar panel to the position of the LDR that was set-up in the programming. There are three points of motor rotation; 0; 90 and 180 degrees. The microcontroller gets an analog input from the Light Dependent Resistor (LDR) which is then converted into digital signal by Analog-to-Digital converter. The movement of the solar panel is determined by the output given to the servo motor. The output of servomotor is determined by the intensity and direction of sunlight falling on the solar panel. Dual axis solar tracking is made possible through this setup.

Here we deal with a combination of wind and solar energy. Wind energy is coupled with solar energy with the help of charging circuit. The output of charging circuit goes to battery. DC output of the battery is converted to AC by using an inverter. The single level inverter is used for the purpose. The output of the inverter is fed to a step up transformer. Transformer output terminals are connected with 4 channel relay unit. The relay unit is controlled by the microcontroller. If the output from the battery is more than that required to drive the AC load, then the extra energy is fed to the grid.

5. EXPERIMENTAL RESULTS AND SETUP

We have developed a hybrid system in which solar and wind energies are utilized efficiently and effectively. Dual axis tracking is made possible with help of 4 LDR 's, 2 servomotors and microcontroller. It is noticed that tracking takes place in the direction in which maximum intensity of light falls. Our 12 V battery requires 5 hours to get charged completely.

Single level inverter gives an output of 12 V, which is stepped up to 230V by using a center tapped transformer. Whenever the output from the battery is greater than that required by the load, the extra energy is fed to the grid. During this time 4 LED's on 4 channel relay module blinks simultaneously. A voltage divider used to demonstrate the result when the output of the battery is not enough to feed the grid works efficiently and can be controlled using a pot. When the voltage from the battery is less than the threshold voltage (set up through the program on the microcontroller), the supply is available only to the load.

Fig. 2: Dual axis solar tracking model

Fig. 3: Wind and solar system prototype model

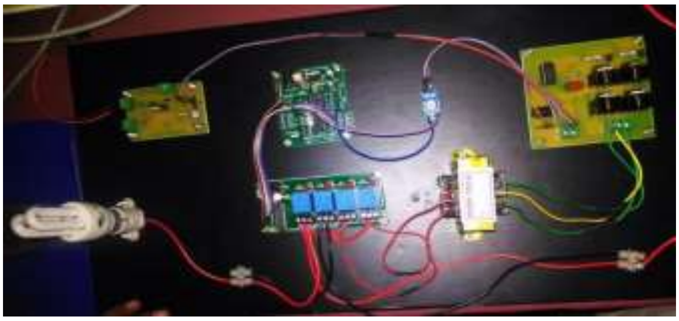

Fig. 4: Inverter, transformer, relay module connection

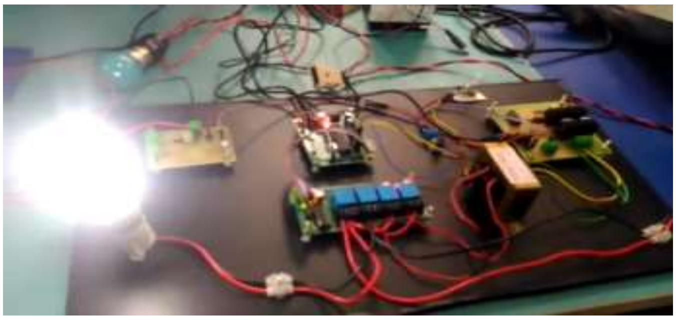

Fig. 5: Working prototype model

6. CONCLUSION AND FUTURE WORK

For villages which are much away from the construction site of large power generating stations such as Hydro and Nuclear, Hybrid wind and solar sources can provide power. Obviously, a complete hybrid power system of this nature may be expensive and to labor intensive for many Industrial Technology Departments. However, many of the same benefits could be gleaned from having some subset of the system, for example, a PV panel, batteries, and an inverter, or even just a PV panel and servomotor. The enhancements to instruction, especially in making electrical power measurements more physical, intuitive, and real-world are substantial and the costs and labor involved in some adaptation of the ideas in this paper to a smaller scale setup are reasonable.

The use of solar and wind hybrid power generation is an especially vivid and relevant choice for students of Industrial Technology as these are power sources of technological, political, and economic importance in their state.

The non- sinusoidal source voltage, source current, and load voltage became sinusoidal with the use of the controller. The controller reduces the reactive power delivered by PV source thus reducing THD of the proposed power system.

In coming years, man will have to increasingly depend on renewable energy sources. Because of the disadvantages involved in using solar or wind energy individually, a hybrid system which avoids the individual advantages will become more famous in coming years. Also, the renewable energy equipment will become cheaper and efficient with modern technology.

With the development of technology, the hybrid system can be installed and maintained at low cost. If this happens, there will be no discontinuity of supply and tariff can be reduced.

7. REFERENCES

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