Hybrid Power Generation Using Dual Axis Solar Tracker and Wind Energy

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Abstract — This project focuses on an integrated hybrid renewable energy system consisting of wind and solar energy. Solar and wind are two renewable means of energy sources that are now gaining attention widely for production of electricity. Solar and wind energy are available in large amount. To enhance the efficiency of the solar system, the project deals with dual axis solar tracking system and wind energy. Proposed plan can be used for rural electrification and modernization of remote areas.

Keywords: Hybrid, Solar, Wind, Microcontroller, Dual Axis, Tracking, Electrification

I. INTRODUCTION

The increasing demand for electrical energy, driven by growing populations and urbanization, is depleting nonrenewable resources like fossil fuels and contributing to global warming. To address these issues, generating energy from renewable resources is essential. This leads to the concept of hybrid solar-wind power generation, which combines solar and wind energy to create a reliable power supply. Although hybrid power stations are not new, they have recently gained popularity. These systems use both wind generators and solar panels to charge batteries and meet energy demands, reducing reliance on fossil fuels and providing clean energy to remote areas without harming the environment. Dual axis solar trackers maximize the energy captured from the sun by following its movement throughout the day, while wind turbines generate power from wind. This combination ensures a steady supply of electricity, even when one source is less available. Hybrid systems are especially useful in remote areas, reducing the need for fossil fuels and minimizing environmental impact. This innovative approach helps meet growing energy demands sustainably and effectively.

II. BLOCK DIAGRAM

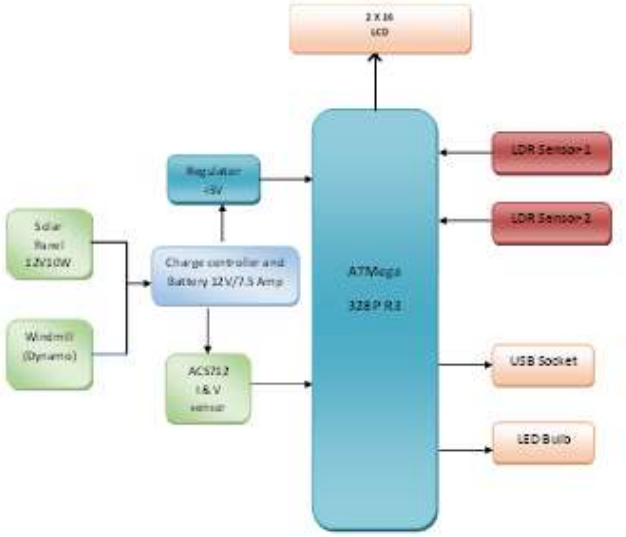


Fig. 1: Hybrid power generation using dual axis solar tracker and wind energy block diagram

A. *Solar Panel:*

- Working Principle: Solar panels convert sunlight into electricity through the photovoltaic effect.
- Function: Solar panels generate clean, renewable energy to power electrical devices and systems.

B. *Windmill:*

- Working Principle: Wind mills convert the kinetic energy of wind into mechanical energy through rotating blades.
- Function: Wind mills generate electricity or perform mechanical tasks like pumping water.

C. *ACS 712 Current Sensor:*

- Working Principle: The ACS712 current sensor measures current by detecting the magnetic field generated by the current flow through a conductor.
- Function: The ACS712 provides an analog output voltage proportional to the detected current, enabling current measurement and monitoring in electrical systems.

D. *LM317 Charge Controller:*

- Working Principle: The LM317 charge controller regulates the output voltage and current by adjusting its internal resistance based on the input voltage and the desired output settings.
- Function: The LM317 charge controller maintains a stable and adjustable voltage to charge batteries efficiently while protecting them from overcharging.

E. 7805 Voltage Regulator:

- Working Principle: The 7805-voltage regulator maintains a constant 5V output by adjusting its internal resistance to compensate for changes in input voltage and load conditions.
- Function: The 7805-voltage regulator provides a stable 5V output to power electronic circuits and devices.

F. LDR Sensor: -

- Working Principle: An LDR (Light Dependent Resistor) changes its resistance based on the intensity of light it is exposed to.
- Function: An LDR is used to detect and measure light levels, enabling automatic light control in various applications.

G. AT mega 328: -

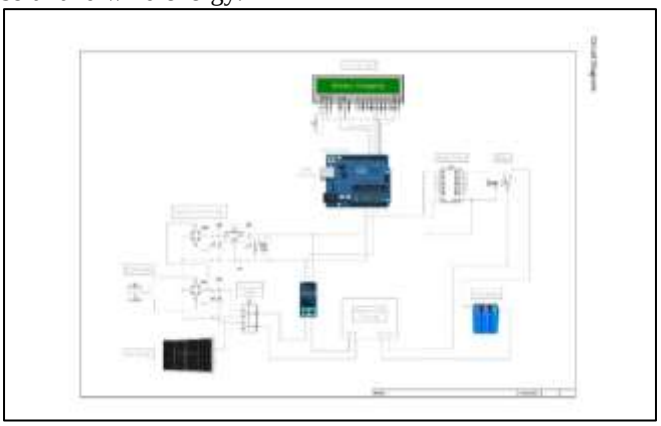
- Working Principle: The ATmega328 microcontroller processes instructions from its memory and interacts with connected components by executing programmed code.
- Function: The ATmega328 on the Arduino Uno board controls and interfaces with various sensors, actuators, and other hardware to build and run electronic projects.

H. LCD Display: -

- Working Principle: An LCD (Liquid Crystal Display) creates images by modulating light through liquid crystals arranged in a matrix.
- Function: An LCD displays visual information, such as text and graphics, on screens for various devices and applications.

III. PROPOSED METHODOLOGY

Here's a proposed methodology for an Hybrid power generation using dual axis solar tracker and wind energy Our project concept aims at extracting maximum power by using solar and wind energy.



We are using light sensors (LDR'S) in solar panels by the status of LDR's the panel rotates in any direction of sunlight, so we can get the maximum power, and DC servo motor (3.5v) in wind turbine for generating the energy.

The output from panel and wind turbine is derived to a DC-DC Boost Converter which is used to increase the voltage without change in current rating they're by increasing the battery charging condition. The sensor (ACS712) sense the respective parameters and it is monitored on LCD screen. The whole system works on 5v DC the regulator (7805) maintains the constant 5v DC for whole system.

IV. HARDWARE AND SOFTWARE DESCRIPTION

A. Hardware Description

1) Arduino UNO

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. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB to- serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:1.0 pinot: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin

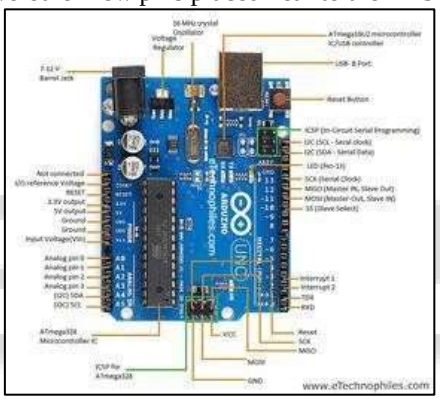


Fig. 3: Arduino Uno Pin Description

2) Solar Panel

A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that produce excited electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules.

Solar panels are usually arranged in groups called arrays or systems. A photovoltaic system consists of one or more solar panels, an inverter that converts DC electricity to alternating current (AC) electricity, and sometimes other components such as controllers, meters, and trackers. A photovoltaic system can be used to provide electricity for off-grid applications, such as remote homes or cabins, or to feed electricity into the grid and earn credits or payments from the utility company. This is called a grid connected photovoltaic system.

Fig. 4: Solar Panel

3) Soil Moisture Sensor:

A servo motor is a linear or rotary actuator that provides fast precision position control for closed-loop position control applications. Unlike large industrial motors, a servo motor is not used for continuous energy conversion.

Servo motors work on servo mechanism that uses position feedback to control the speed and final position of the motor. Internally, a servo motor combines a motor, feedback circuit, controller and other electronic circuit.

Fig. 5: Servo Motor

4) Battery

A 12V 3.3A battery is a rechargeable battery with a voltage output of 12 volts and a capacity of 3.3 ampere-hours (Ah). This type of battery is commonly used in various electronic devices, such as small appliances, power tools, and certain types of backup power systems. The voltage (12V) indicates the electrical potential difference, and the capacity (3.3Ah) represents the amount of charge the battery can store and deliver.

It can deliver a continuous current of 3.3 amps for one hour before needing to be recharged.

Fig. 6: Battery

5) LM317 CHARGE CONTROLLER

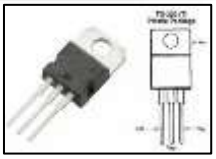


Fig. 7: LM 317 Charge Controller

The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.25 V to 37 V. It requires only two external resistors to set the output voltage.

FEATURES:

- Output voltage range adjustable from 1.25 V to 37 V
- Output current greater than 1.5 A
- Internal short-circuit current limiting
- Thermal overload protection
- Output safe-area compensation

6) Voltage Regulator

Fig. 8: 7805 Voltage Regulator

The 7805 Voltage Regulator IC is a commonly used voltage regulator that finds its application in most of the electronics projects. It provides a constant +5V output voltage for a variable input voltage supply.

FEATURES:

- 5V Positive Voltage Regulator
- Minimum Input Voltage is 7V
- Maximum Input Voltage is 25V
- Operating current(IQ) is 5mA
- Internal Thermal Overload and

Short circuit current limiting protection is available.

7) ACS712 current sensor

Fig. 9: ACS712 current sensor

The Allegro® ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection

Benefits and features:-

1) Low-noise analog signal path
2) 80 kHz bandwidth
3) 5.0 V, single supply operation
4) 66 to 185 mV/A output sensitivity
5) Output voltage proportional to AC or DC current.

8) LDR SENSOR

An LDR, or Light Dependent Resistor is a type of optoelectronic sensor that's used for detecting light in the environment. It works by sensing changes in illumination and converting them into electrical signals which can be read off from its two terminals. This makes it an essential tool in many automation systems because it helps detect objects without any physical contact with them.

Fig. 10: LDR Sensor

B. Software Description

Fig. 11: Arduino IDE Interface

Arduino is a type of computer software and Hardware Company that offers open-source environment for user

project and user community that intends and fabricates microcontroller-based inventions for construction digital devices and interactive objects that can sense and manage the physical world. For programming the microcontrollers, the Arduino proposal provides a software application or IDE based on the Processing project, which includes C, C++ and Java programming software. It also supports for embedded C, C++ and Java Programming software.

V. CONCLUSION

From This Project We Conclude That Hybrid Power Generation Using solar and wind energy Have a Large Base of Application in power production. Hybrid power generation system is good and effective solution for power generation than conventional energy resources. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. It is cost effective solution for generation. It only needs initial investment. It has also long-life span. Overall, it good, reliable and affordable solution for electricity generation.

VI. FUTURE SCOPE

The future scope of Dual axis solar tracker and wind energy Includes

1) Hybrid Renewable Energy Systems: Integrating dual axis solar trackers with wind turbines in hybrid systems can provide a more reliable and consistent energy output. Such systems can maximize the use of available land and resources, offering a balanced energy production by compensating for the intermittency of each source.
2) Increased Efficiency and Reliability: By combining solar and wind energy, the overall efficiency and reliability of power generation can be improved. Dual axis solar trackers optimize solar panel performance by following the sun's path, while wind turbines generate power when solar radiation is low, such as during cloudy or nighttime conditions.
3) Smart Grid Integration: The integration of hybrid systems into smart grids can enhance grid stability and efficiency. Real-time data from both solar trackers and wind turbines can be used for predictive maintenance, load balancing, and optimizing energy distribution.
4) Energy Storage Solutions: Advanced energy storage technologies, such as batteries or pumped hydro storage, can be paired with hybrid systems to store excess energy generated during peak production times. This stored energy can then be used when production is low, ensuring a continuous power supply.
5) Cost Reduction and Economic Viability: Combining solar and wind energy systems can reduce overall costs by sharing infrastructure, such as inverters, grid connections, and maintenance services. This makes renewable energy projects more economically viable and attractive to investors.

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