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ELECTRICITY GENERATION BY USING UPRIGHT BIKE

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Abstract

Electricity generation using a bicycle is a simple and eco-friendly method of producing electrical energy through human power. This project converts mechanical energy generated by pedaling a bicycle into electrical energy using a dynamo or generator. The generated electricity can be stored in a battery and used for small devices such as mobile charging, LED lights, or emergency power supply. This system is useful in rural areas where electricity access is limited and promotes renewable energy and physical exercise

Introduction

The increasing demand for electricity and the depletion of fossil fuels have created the need for alternative and renewable energy sources. Human power is one such renewable energy source that can be utilized for electricity generation. A bicycle generator system converts the mechanical energy produced by pedaling into electrical energy.

This method is simple, low-cost, and environmentally friendly. It can be used in homes, gyms, rural areas, and emergency situations

Need For Cycle Power Generation

The rapid increase in population and technological development has led to a significant rise in electricity consumption worldwide. At the same time, the availability of conventional energy resources such as coal, petroleum, and natural gas is gradually decreasing. These resources are non-renewable and take millions of years to form. Their excessive usage not only leads to resource depletion but also causes severe environmental issues such as air pollution, greenhouse gas emissions, and global warming.

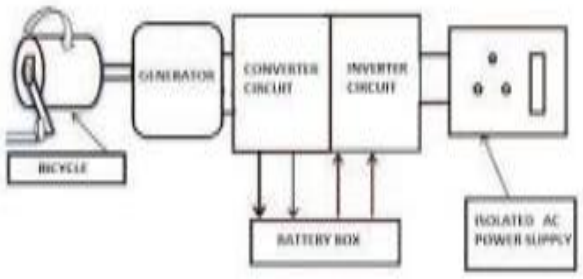
In many developing countries, especially in rural areas, electricity supply is either unreliable or completely unavailable. People living in such regions often face difficulties in performing basic tasks like charging mobile phones, lighting homes, or powering small electrical devices. Therefore, it becomes essential to develop simple and cost-effective power generation systems that can operate independently of the main power grid.

The Cycle Power Generation System addresses this need by utilizing human

effort to generate electricity. Bicycles are widely available and commonly used for transportation. By attaching a generator mechanism to the bicycle, the energy generated during cycling can be converted into electrical energy. This makes the system highly practical, economical, and easy to implement.

Another important advantage of this system is that it encourages physical exercise while simultaneously producing electrical energy. This dual benefit makes the system suitable for homes, educational institutions, gyms, and public places. People can contribute to energy generation while maintaining their health and fitness.

Working Principle of the System



The working principle of the Cycle Power Generation System is based on the conversion of mechanical energy into electrical energy. When the rider pedals the bicycle, the rotational motion of the wheel drives the DC generator motor attached to the bicycle frame. As the generator rotates, it produces DC electrical energy.

The generated energy is stored in a **12V lead-acid battery**, which acts as the main power source for the system. From the battery, the electrical energy is distributed to various loads and circuits.

A **7805 voltage regulator IC** converts the battery voltage into a stable 5V supply required for the **ESP8266 microcontroller** and the **LCD display**. The **buck converter** is used to regulate and adjust the voltage for mobile charging modules and other low-voltage electronic devices.

The system also includes a **100-Watt inverter circuit**, which converts the stored 12V DC power into AC power using a **12-0-12 step-up transformer**. This allows the system to power AC loads such as an **AC lamp** connected through a **3-pin socket**.

Various **toggle switches and slide switches** are used to control different parts of the circuit, including generator charging, inverter operation, and load switching.

Hardware Requirement

1. Cycle

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The bicycle is the primary mechanical component of the Cycle Power Generation System. It acts as the source of mechanical energy required to drive the generator. When a person pedals the bicycle, the rotational motion of the pedals is transferred to the rear wheel through a chain drive mechanism. This rotational motion is then used to rotate the generator motor attached to the bicycle frame

A standard bicycle is used in this project because it is easily available, economical, and capable of producing continuous rotational motion. The mechanical energy generated by the cyclist is directly proportional to the pedaling speed and effort applied by the rider.

2. 12V 300 RPM DC Generator Motor

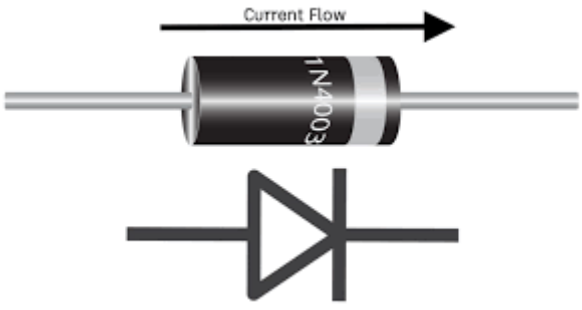
The **12V 300 RPM DC generator motor** is the main electrical energy generation device used in this project. A DC motor can work as a generator when its shaft is rotated mechanically. When the motor rotates, it produces DC voltage across its terminals due to the principle of **electromagnetic induction**.

In this system, the generator motor is connected to the bicycle wheel. When the cyclist pedals the bicycle, the wheel rotates and drives the generator motor shaft. As the motor rotates, it generates DC electrical energy.

The generator used in this project has the following characteristics:

- Rated Voltage: 12V
- Speed: 300 RPM
- Output Type: DC Voltage
- Compact and lightweight design

3. Diode



A **diode** is a semiconductor device that allows current to flow in only one direction. In this project, the diode is used as a **reverse current protection device**.

When the generator produces electricity, the current flows toward the battery to charge it. However, when the generator stops rotating, there is a possibility that the battery could discharge back into the generator. This reverse current could damage the generator or reduce battery efficiency.

To prevent this problem, a diode is connected between the generator output and the battery input. The diode allows current to flow from the generator to the battery but blocks current from flowing in the opposite direction.

4. Capacitor

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A **capacitor** is an electrical component used to store and release electrical energy. In this project, the capacitor is used to stabilize and smooth the voltage generated by the DC generator motor.

Since the pedaling speed of the cyclist may vary continuously, the generator output voltage may fluctuate. These fluctuations can affect sensitive electronic components in the system.

The capacitor helps to filter out these fluctuations by storing excess energy during voltage peaks and releasing energy during voltage drops. This process

produces a more stable DC output voltage.

Capacitors are commonly used in power supply circuits to improve voltage stability and reduce electrical noise.

5. 12V 1.3Ah Lead Acid Battery

The **12V 1.3Ah lead acid battery** is used as the energy storage device in the Cycle Power Generation System. The battery stores the electrical energy generated by the generator so that it can be used later when the bicycle is not in operation.

Lead-acid batteries are widely used in small power systems due to their reliability, low cost, and simple charging requirements.

Specifications of the battery include:

- Voltage: 12V
- Capacity: 1.3Ah
- Rechargeable type

6. 7805 Voltage Regulator IC

The **7805 IC** is a voltage regulator used to provide a stable **5V DC output**. Many electronic components such as microcontrollers and display modules require a constant 5V power supply.

The input voltage from the battery may vary between 9V and 12V depending on the charging condition. Such voltage variations can damage sensitive electronic devices.

The 7805 regulator solves this problem by converting the input voltage into a constant 5V output regardless of input fluctuations.

The IC has three terminals:

- Input
- Ground
- Output

7. ESP8266 Microcontroller

The **ESP8266** is a low-cost microcontroller with built-in Wi-Fi capability. It is used as the main control unit of the system.

The ESP8266 processes data from the voltage sensor and controls the display unit. It monitors the battery voltage and generator output voltage and sends this information to the LCD display.

Main features of ESP8266 include:

- Built-in Wi-Fi connectivity
- Low power consumption
- High processing speed
- Support for IoT applications

8. 0–25V Voltage Sensor

The **0–25V voltage sensor module** is used to measure the voltage generated by the generator and stored in the battery.

This sensor reduces the input voltage to a level that can be safely read by the microcontroller's analog input pin. The ESP8266 reads this value and calculates the actual voltage.

This allows the system to monitor:

- Generator output voltage
- Battery charging voltage

9. 16×2 LCD Display with I2C Module

The **16×2 LCD display** is used to display system parameters such as voltage levels and system status.

A 16×2 LCD means it can display **16 characters per line and 2 lines of text**. The I2C module reduces the number of connection wires required between the LCD and microcontroller.

The LCD displays information such as:

- Generator voltage
- Battery voltage
- Charging status

10. Buck Converter

converter is a DC-DC step-down converter used to reduce voltage efficiently.

In this project, the buck A **buck** converter reduces the battery voltage to

the required level for mobile charging modules and other electronic devices.

Buck converters are preferred because they have **high efficiency and low heat generation** compared to linear voltage regulators.

11. Mobile Charging Module

The **mobile charging module** provides a USB output port for charging smartphones and other portable electronic devices.

It converts the battery voltage into a stable **5V USB output** required by mobile phones. This feature demonstrates a practical application of the cycle power generation system.

Users can charge their mobile phones simply by pedaling the bicycle.

12. 100W Inverter Circuit

The **100-watt inverter circuit** converts DC power from the battery into AC power. This allows the system to operate AC electrical devices.

The inverter uses electronic switching components and a **12-0-12 step-up transformer** to convert 12V DC into higher voltage AC.

This enables the system to power AC loads such as lamps and small appliances

13. 12-0-12 Step-Up Transformer

The **12-0-12 transformer** is used in the inverter circuit to increase the voltage from the DC source and convert it into AC output.

The center-tapped design allows the inverter circuit to generate alternating current by switching between the two windings.

This transformer plays an important role in producing usable AC power.

14. DC Voltmeter

The **DC voltmeter** is used to measure and display the battery voltage directly. It provides a quick visual indication of the battery charging level.

Objective

- To generate electricity using a bicycle.
- To convert mechanical energy into electrical energy.
- To provide a low-cost renewable energy solution.

Software Requirement

1. **Arduino Integrated Development Environment**

The **Arduino IDE** is an open-source software platform used to write and upload programs to microcontrollers such as Arduino boards and ESP8266 modules. It provides a simple and user-friendly interface that allows developers, students, and engineers to create embedded system applications easily.

The Arduino IDE supports programming using the **C and C++ languages**, which are widely used in embedded system development. It also includes many built-in libraries that simplify communication with sensors, displays, and other electronic devices.

1. **Code Editor:-** The code editor is the main section where the user writes the program. It provides features such as syntax highlighting, automatic indentation, and error detection to make programming easier.
2. **Compile**r:- The compiler converts the written program into machine code that can be executed by the microcontroller. If there are any errors in the code, the compiler displays error messages so that the programmer can correct them.
3. **Upload Tool:-** Once the program is compiled successfully, it is uploaded to the microcontroller through a USB connection. The microcontroller then stores the program in its memory and starts executing it.
4. **Serial Monitor:-** The serial monitor is a tool used for debugging and testing the program. It allows the user to view sensor readings and messages sent from the microcontroller in real time.The Arduino IDE is widely used in engineering projects because it is simple, reliable, and supports a wide range of hardware platforms.

2. **ESP8266 Microcontroller Programming**

The **ESP8266 microcontroller** is the main processing unit of the Cycle Power Generation System. It performs several important tasks, including reading sensor data, processing information, and controlling the display module.

The ESP8266 contains an **Analog-to-Digital Converter (ADC)** that converts analog voltage signals from the voltage sensor into digital values that can be processed by the microcontroller. The microcontroller reads these values through its input pins and calculates the actual voltage using mathematical formulas.

After calculating the voltage value, the microcontroller sends the data to the **16×2 LCD display** using the I2C communication protocol. The LCD then displays the voltage readings so that the user can monitor the system status.

The ESP8266 runs the program continuously in a loop. The program repeatedly performs the following tasks:

- Read voltage from the voltage sensor
- Convert analog data into digital values
- Calculate the actual voltage level
- Display the voltage on the LCD screen
- Repeat the process continuously

3. **Embedded C Programming Language**

The programming language used for the Cycle Power Generation System is **Embedded C**, which is a specialized version of the C programming language used for microcontroller-based systems.

Embedded C allows programmers to interact directly with hardware components such as sensors, displays, and communication modules. It provides efficient control over the microcontroller's memory and processing resources.

1. **Library Inclusion:-** In this section, required libraries are included in the program. Libraries contain predefined functions that simplify hardware communication.
2. **Variable Declaration:-** Variables are defined to store sensor readings, voltage values, and other system parameters.
3. **Setup Function:-** The setup function runs only once when the system starts. It initializes the microcontroller, LCD display, and communication interfaces
4. **Loop Function:-** The loop function runs continuously and contains the main instructions of the program. It reads sensor values, processes data, and updates the display.

4. **Advantages of the Software System**

The software system used in the Cycle Power Generation project provides several benefits.

First, it allows **real-time monitoring of generated voltage**, which helps users understand how much electrical power is being produced.

Second, the use of the **Arduino IDE simplifies programming and debugging**, making the system easy to develop and maintain.

Third, the **ESP8266 microcontroller provides fast data processing**, ensuring accurate voltage measurement.

Finally, the software can be easily modified to add additional features such as **IoT monitoring, data logging, or wireless communication**.

Advantages

1. **Renewable Energy Source**:-The cycle power generation system uses human energy to produce electricity. Human power is a renewable and unlimited energy source, which makes the system environmentally friendly.
2. **Eco-Friendly System:-**This system does not produce any harmful gases or pollution. It helps reduce the use of fossil fuels and contributes to environmental protection.
3. **Low Cost Implementation**:-The components used in this project such as DC generator motor, battery, voltage regulator, and microcontroller are easily available and inexpensive. This makes the system economical and suitable for educational purposes.
4. **Simple Design and Easy Maintenance:-**The system has a simple structure and does not require complicated machinery. Maintenance is easy because the components used are standard electronic devices.
5. **Energy Conservation:-**The project promotes energy conservation by generating electricity from human effort. It encourages people to use alternative energy sources instead of relying completely on conventional power systems.
6. **Useful During Power Failures:-**The system can provide electricity during power outages. It can power small

devices such as LED lights, mobile chargers, and other low-power equipment.

7. **Promotes Physical Fitness:-**The system encourages cycling, which is a healthy physical activity. It helps users stay fit while generating electricity at the same time.

Disadvantages

1. **Limited Power Generation:-** The amount of electricity generated depends on the pedaling speed and effort of the cyclist. Therefore, the system can only produce a limited amount of power.
2. **Human Effort Required:-** Continuous electricity generation requires constant pedaling. If the user stops cycling, the power generation stops.
3. **Charging Time May Be High:-** Charging the battery completely may take longer because the generated power is relatively small.
4. **Efficiency losses:-**Some energy is lost due to mechanical friction, electrical resistance, and conversion losses in the generator and inverter circuits.

Applications

1. **Rural Electrification**:-The system can be used in rural and remote areas where electricity supply is limited or unavailable.
2. **Emergency Power Supply**:-It can be used during power failures or natural disasters to generate emergency electricity.
3. **Mobile Charging Stations**:-The system can be used to charge mobile phones and small electronic devices by pedaling the bicycle.
4. **Educational Demonstration**:-Engineering colleges and schools can use this project as a demonstration model to teach students about renewable energy and power generation.
5. **Gym and Fitness Centers**:-Exercise bicycles in gyms can be connected to generators to produce electricity while people exercise.
6. **Street Lighting in Remote Areas**:-The generated electricity can be used to power small LED lights in areas where grid electricity is not available.
7. **Camping and Outdoor Activities**:-The system can be used in camping sites or outdoor environments to generate electricity for lighting and small devices.
8. **Research and Development**:-The project can be used for further research in renewable energy technologies and human-powered energy systems.
9. **Battery Charging Systems**:-It can be used to charge small batteries used in portable electronic devices.
10. **Small Household Applications**:-The system can power small household devices such as LED lamps, radios, and fans for short periods.

Result

The Cycle Power Generation System was successfully designed and implemented to demonstrate the generation of electrical energy using human power. The system effectively converts mechanical energy produced by pedaling a bicycle into electrical energy using a **12V 300 RPM DC generator motor**. When the bicycle wheel rotates, the generator motor produces DC voltage which is stored in a **12V 1.3Ah lead-acid battery**.

During the testing phase, it was observed that the generator produces varying voltage depending on the speed of pedaling. When the cyclist pedals slowly, the generated voltage is low, whereas faster pedaling produces higher voltage output. The generated electrical energy is stabilized using capacitors and

protected using diodes before being stored in the battery.

The **0–25V voltage sensor** successfully measured the generated voltage and battery voltage. These values were processed by the **ESP8266 microcontroller** and displayed on the **16×2 LCD display with I2C module**, allowing real-time monitoring of the system.

The stored electrical energy in the battery was used to operate various loads such as:

- **12V LED light**
- **Mobile charging module**
- **AC lamp through a 100W inverter circuit**

The inverter circuit with a **12-0-12 step-up transformer** successfully converted the stored 12V DC power into AC power, which could operate small AC loads connected through a **3-pin socket**.

The system demonstrated that electrical power generated through cycling can be used for practical applications such as lighting, mobile charging, and operating small electrical appliances. The experiment confirmed that the Cycle Power Generation System is capable of producing usable electrical energy through human effort.

Conclusion

The Cycle Power Generation System is an innovative and eco-friendly method of generating electrical energy using human effort. The system converts the mechanical energy produced by cycling into electrical energy using a DC generator motor. This electrical energy is stored in a rechargeable battery and can be used for various practical applications.

Future Scope

Although the Cycle Power Generation System is effective for small-scale power generation, there are several improvements and advancements that can be implemented in the future to enhance its performance and efficiency.

One possible improvement is the integration of **higher efficiency generators or permanent magnet alternators**. These generators can produce higher electrical output with less mechanical effort, improving overall system efficiency.

Another improvement is the use of **lithium-ion batteries instead of lead-acid batteries**. Lithium-ion batteries have higher energy density, longer lifespan, and faster charging capability, which would improve the energy storage capacity of the system.

The system can also be upgraded with **Internet of Things (IoT) technology** using the Wi-Fi capability of the ESP8266 microcontroller. This would allow users to monitor system performance remotely using mobile applications or cloud platforms.

Future versions of the project can also include **energy management systems** that automatically control battery charging and load distribution to improve energy efficiency.

In addition, multiple bicycles can be connected together to create a **multi-cycle power generation system**, which could generate higher electrical output suitable for larger applications such as powering community lighting systems or small facilities.

The system can also be implemented in **gyms and fitness centers**, where exercise bicycles can generate electricity

while people work out. This would help produce useful electrical energy while promoting fitness and sustainability.

Further research and development in this area can lead to more efficient and practical human-powered energy systems, contributing to the development of sustainable energy technologies.

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