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Design and Development of an Eco-Friendly Battery-Operated Brush Cutter

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Abstract
This research focuses on the design and development of an eco-friendly, battery-operated brush cutter. Traditional gasoline-powered brush cutters contribute to air pollution and noise pollution. This project aims to address these environmental concerns by introducing a sustainable alternative. The proposed brush cutter utilizes a high-performance, brushless DC motor powered by a rechargeable lithium-ion battery. This configuration eliminates the need for harmful fuel emissions and reduces noise levels. The design emphasizes ergonomics and user comfort, incorporating features like vibration reduction mechanisms and a well-balanced structure.

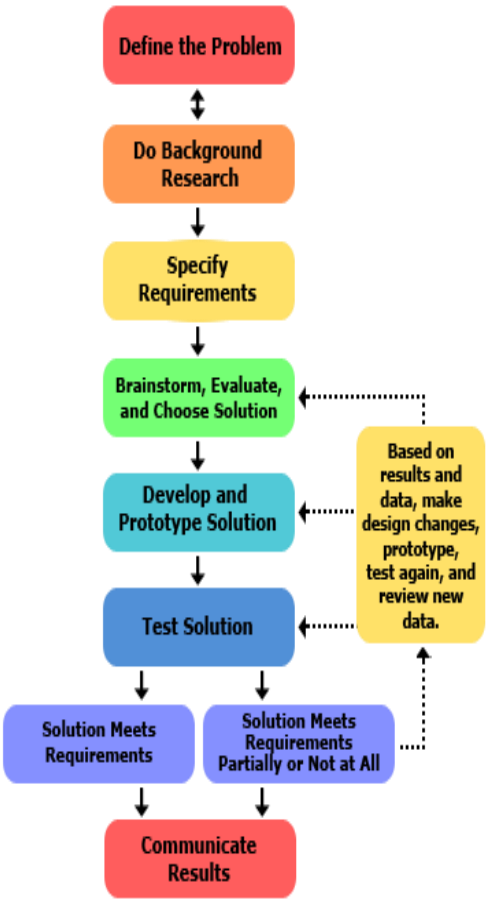
1. Introduction

Increasing Ecological, Green Threats and The Global Emphasis on Sustainable Practices, The Need for Eco-Friendly Alternatives to Traditional Equipment Has Grown Significantly. Brush Cutters, Widely Used for Trimming Grass, Clearing Weeds, And Managing Small Shrubs, Are Essential Tools in Landscaping, Gardening, And Agricultural Maintenance. However, Conventional Brush Cutters Powered by Fossil Fuels Contribute to Harmful Airborne Particles, Climate-Altering Gases, And Noise Pollution. These Drawbacks Have Necessitated the Shift Towards Cleaner and More Sustainable Solutions. This project aims to design and develop an eco-friendly battery-operated brush cutter that integrates innovative features to meet the needs of modern users. The proposed solution will focus on the following objectives.

2. Objectives

- Sustainability
- To Reduce Air Pollution
- Efficiency
- Portability and Ergonomics
- Cost-Effectiveness

3. Methodology



Component of attachments:

1. DC Motor
2. Lithium-Ion Rechargeable Battery
3. Rod
4. Cutting Blades
5. Safety Guard
6. Handle Bar
7. Adjustable Clamps

4. Components

DC Motor

- The motor is such an electric device that converts electrical energy into mechanical power. The working of these motors depends on the interaction of the field at the stator with the flux generated by the current armature windings at the rotor. Overview of 1500 RPM, 12W, 25mm DC Motor. A compact, efficient DC motor ideal for robotics, small machines, and automation systems.

Key features

- Nominal Voltage
- 12V DC Motor
- Power:12W
- Speed: 1500 RPM
- Shaft Diameter: 25 mm

Lithium-ion battery

- Battery Voltage Common voltage options: 12V, 24V, or 48V.Choose based on your motor or device requirements.one battery running period is 1.5 – 2 hours max.
- Capacity (Ah)Power (W) = Voltage (V) × Capacity (Ah). For a 48W.

- Battery At 12V: Capacity = 48W ÷ 12V = 4Ah.At 24V: Capacity = 48W ÷ 24V = 2Ah.At 48V: Capacity = 48W ÷ 48V = 1Ah.
- Weight Around 0.5–1.5 kg, depending on capacity and form factor. Cycle Life300–1000 cycles.
- Charging Parameters Charge Voltage: Typically, 4.2V per cell (e.g., 12.6V for a 3S battery). Charging Current: 0.5C–1C of capacity (e.g., 2A for 4Ah capacity).

Brush Cutter

- Brush cutter machine blades exist in different variations, each designed for particular tasks and vegetation types. Choosing the right blade depends on the material you need to cut. Here's an overview.

- **Steel Blades**: Durable and robust, designed for heavy-duty cutting.
- **Carbide-tipped Blades**: Long-lasting and efficient, perfect for professional use.
- **Alloy Blades**: Lightweight and resistant to rust, ideal for general use.
- Blade 15cm diameter and MS plate mild steel.

Safety Guard

- A grass cutter safety guard is an essential feature on lawnmowers and grass trimmers that helps to protect users from debris, accidental contact with moving parts, and potential injury.
- The safety guard is typically made of durable plastic or metal and is designed to cover or shield the blade or cutting mechanism.
- Prevents debris from being thrown into the operator's body or face.
- Reduces the risk of accidental injury by keeping the user away from the cutting blades.

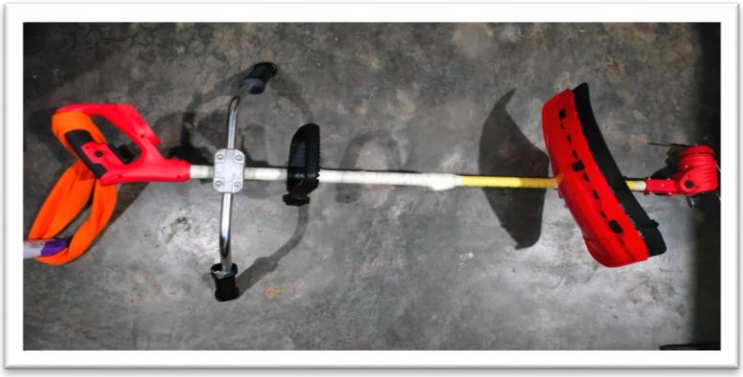
Handle bar

- **U-shaped Handlebar**: This type is more commonly seen on heavier-duty grass cutters or brush cutters. The U-shaped handlebar gives more control and is ergonomically designed to reduce strain on the user's arms and back.
- It’s ideal for more extensive or challenging grass cutting and can be used with more powerful engines.

Working principles

- **Energy Supply**: The user charges the high-capacity lithium-ion battery, which stores electrical energy.
- **Energy Conversion**: When the user activates the trigger, the stored energy powers the brushless DC motor.
- **Rotational Motion**: The motor generates rotational energy, transmitted to the cutting mechanism via a direct drive or gearbox.
- **Cutting Action:** The blade (or nylon cord) spins at high speed, efficiently cutting grass, shrubs, and small bushes.
- **User Control**: The motor speed is adjustable using the trigger switch, allowing for energy conservation during lighter tasks.
- **Safety Features**: Sensors may shut down the motor during overheating or overload, protecting components and ensuring user safety**.**

5. Final project model



6. Result

1. **Environmental Sustainability**: By eliminating dependence on fossil fuels, the battery-operated brush cutter reduces carbon emissions and air pollution. Its quiet operation also minimizes noise pollution.
2. **Ergonomic Design**: The device has been enhanced for ease of use, incorporating lightweight materials and ergonomic handles to enhance user comfort during extended periods of operation.
3. **Energy Efficiency**: Advanced lithium-ion batteries provide longer run times, quick charging capabilities, and high power output, making the tool both reliable and efficient.
4. **Versatility and Performance**: Designed to handle various vegetation types, the cutter maintains high cutting performance across diverse terrains.

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