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Powered Wheelbarrow

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Abstract: Studies have shown that most users experience difficulties with the maneuverability of their strollers, particularly in terms of wheelbarrows. These issues are often caused by a variety of factors, such as carrying heavy loads, especially during wet seasons, which can make it difficult to grip the handles and navigate through slippery or uneven terrain. To address these issues, powered wheelbarrows have been developed. These allow for larger loads to be carried with less effort, as the employees only need to exert a small amount of force to move the wheelbarrow smoothly. A Brushless DC Motor is used for the primary part of this project. 350W 24V Brushless DC Motor will be used as the actuator of the entire system to move a wheelbarrow without requiring much workforce. Then, the brushless motor controller is used as the microcontroller for the system. The controller can regulate the motor's speed and the forward/reverse motion of a wheelbarrow. This can improve the overall safety of the wheelbarrow and make it more user-friendly. The powered wheelbarrows will be tested in three different categories: construction, agriculture, and factory. In this project, the load level will be tested on various types of surfaces to evaluate the effect of surface type and load level on the performance of the wheelbarrow. The aim is to determine how the performance or speed of the wheelbarrow when used on various surfaces and the difference in load weight to understand the relationship between the type of surface and load level. This information can be used to improve the design and structural performance of the wheelbarrow.

Keywords: Powered Wheelbarrow, Brushless DC Motor, Motor Controller, Different Load and Surface Area

1. Introduction

Manual wheelbarrows are a traditional type of wheelbarrow that typically consist of sloping sides and one front wheel. These types of wheelbarrows are often used in industries such as landfills, agriculture, and construction, as they are easy to control and convenient for moving materials such as

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manure, soil, and stones. However, some researchers have found that manual wheelbarrows have some drawbacks, particularly when it comes to their small size, which can make it difficult to transport larger quantities of materials such as palm oil bunches. Additionally, manual wheelbarrows can be difficult to turn when they are fully loaded, and they can become unbalanced when lifted over obstacles or uneven surfaces. Carrying heavier loads during wet seasons can also make it difficult to grip the handles and move the wheelbarrow across smooth or slick surfaces. Furthermore, manual wheelbarrows lack a brake component, making it difficult for users to immediately stop the wheelbarrow, particularly on sloping roads. Moreover, manual wheelbarrows cannot absorb vibrations, making control and handling less efficient.

The powered wheelbarrow is a type of wheelbarrow that is equipped with a motor and battery, which allows it to be operated without the need for manual pushing. The main benefit of this type of wheelbarrow is that it enables the easy transport of heavy loads, which can be especially useful in industries such as construction, agriculture, and factories where large amounts of materials need to be moved quickly and efficiently. The powered wheelbarrow reduces the amount of force required to push the wheelbarrow, which can help to reduce the risk of injury or strain for employees. Additionally, it can navigate slippery or uneven terrain easily, making the process of moving materials faster and more efficient.

The main objective of this project is to develop a motorized mechanism for a powered heavy-duty wheelbarrow. This includes integrating a wheelbarrow with a brushless motor and a drive mechanism that can move the wheelbarrow. The effectiveness of the powered wheelbarrow will be evaluated by testing it under different load and surface conditions. The main goal is to make it easier for users to push the wheelbarrow and to enable it to carry heavier loads beyond what a human alone could transport. The motor used in this project is a brushless DC motor that is designed to move the wheelbarrow with minimal effort. Additionally, the design will consider the different terrains and surfaces that the wheelbarrow may encounter, to ensure that it can navigate them easily. The effectiveness of the powered wheelbarrow will be evaluated by measuring the effort required to push it, the load it can carry and how well it can handle different surfaces. Overall, the goal of this project is to create a powered wheelbarrow that is more efficient, safer, and easier to use than manual wheelbarrows.

2. Materials and Methods

Throughout the project and development of powered wheelbarrow, the project flowchart asshown in figure 1 is used to represent the overall workflow of the development process.

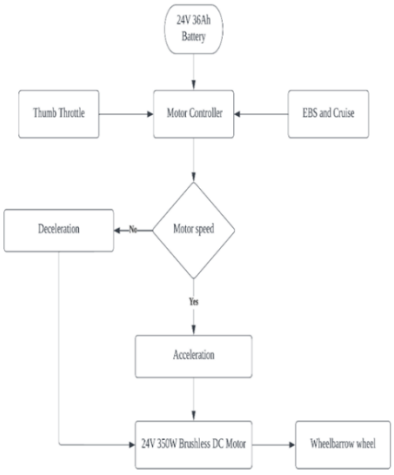

Figure1: Project Flowchart

2.1 Flowchart Explanation

The Figure 1 illustrates the flow of the project. The process starts when the motor, which is powered by a battery, is activated. The battery also powers the motor controller, which allows for control of the motor's on/off state, rotation direction, speed, torque, and protection against overload and electrical damage. The throttle is connected directly to the motor controller, enabling control of the motor's acceleration or deceleration. As the motor starts to move, the wheel of the wheelbarrow

will also begin to rotate. An Electronic brake system (EBS) is provided for safety, allowing the operator to stop or slow down the wheelbarrow while it is on a slope or uneven terrain.

2.2 System Block Diagram

A block diagram is used to depict the operation or screen navigation of the entire system of powered wheelbarrow. Figure 2 depicts a simple block diagram of the brushless DC Motor, Lithium Ion Battery, Motor controller, Thumb throttle, and electronic brake system (EBS).

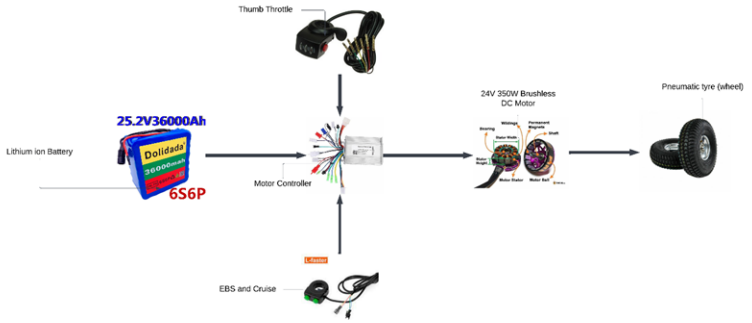

Figure 2: Simple system block diagram

Figure 2 illustrates a comprehensive system block diagram. The brushless motor controller is chosen as the microcontroller for this system because it can regulate the motor's speed, as well as the wheelbarrow's forward/reverse motion. The power supply is used to power both the microprocessor and the motor driver. The digital input component consists of the forward and backward buttons which are connected to the microcontroller for digital transmission input. The button is also connected to the microcontroller and is used to manually control the movement of the wheelbarrow. Additionally, the throttle is connected to the microcontroller to control the motor's speed or RPM. The electronic brake system (EBS) is included in the system for added safety. It is used to assist the user in stopping the wheelbarrow when on a slope. The EBS controls the movement of the wheel, and the user can regulate it by pressing the EBS button.

2.3 Material

2.3.1 Brushless DC Motor

Brushless motors are a type of electric motor that have several advantages over traditional brushed motors. These advantages include higher output power, smaller and lighter size, better heat dissipation and efficiency, a wider range of operating speeds, and very low electrical noise during operation. Additionally, brushless motors do not have any electrical connections that wear out, which makes them more reliable and reduces the need for maintenance in commercial and industrial applications. Due to these benefits, brushless motors are often preferred for certain projects, such as the one described in the sentence.

2.3.2 Lithium Ion Battery

A 24V lithium-ion rechargeable battery is a type of battery that is designed to store electrical energy for later use. These batteries are widely used as a power source for a variety of different systems, including uninterruptible power supply (UPS) units, electric cars, and power tools. One of the key benefits of lithium-ion batteries is that they can be recharged multiple times, making them an effective and cost-efficient alternative to disposable batteries. This ability to recharge the battery means they can be used repeatedly, thus reducing the need to replace them frequently, which can be costly and environmentally harmful. Additionally, lithium-ion batteries have higher energy density, longer lifespan, and lower self-discharge rate compared to other types of batteries.

2.3.2 Motor Controller

An electronic module, commonly referred to as the motor controller, acts as the intermediary between the batteries and the electric motor in an electric vehicle. This controller receives input from the throttle and uses it to control the speed and acceleration of the vehicle. The controller also plays a critical role in the powertrain of the vehicle by converting the direct current (DC) power from the batteries into alternating current (AC) power, which is necessary for the operation of the electric motor. Additionally, the controller regulates the flow of energy from the batteries to the motor to ensure optimal performance and efficiency. This is an important component in an electric vehicle's drivetrain and is necessary for the proper functioning of the vehicle.

2.3.2 Electronic Brake System (EBS)

An electronic braking system (EBS) is a safety feature that helps improve the performance of a vehicle's braking system. EBS uses a variety of sensors to continuously monitor the speed of each wheel, as well as the pressure being applied to the brakes. If one of the wheels starts to lock up, the EBS system will automatically apply the brakes to that wheel, which can help prevent sliding and loss of control. This can be particularly useful in situations where the vehicle is traveling at high speeds or on slippery road surfaces, as it can significantly reduce stopping distances. Additionally, when the driver applies the brakes forcefully, the EBS system can provide a boost to the brakes, giving the vehicle an extra burst of stopping power. This can be helpful in emergency braking situations, allowing the vehicle to come to a stop more quickly and safely.\

3 Results and Discussion

In this project, the results and information obtained from the testing were presented in a clear and organized manner. The project discussed the differences in area, type of soil, and terrain class, as well as the capacity limits of the wheelbarrow. All this information was collected to identify the needs of the analyst. This process of collecting and analyzing data is crucial in determining the outcome of the analysis studies. By describing the results in depth and in the correct order, the project allows the reader to understand the testing process and the significance of the results. The discussion of the differences in area, type of soil, and terrain class, as well as the capacity limits of the wheelbarrow, provides a comprehensive understanding of the testing conditions and how they may have affected the results. Overall, this project demonstrates a thorough and organized approach to analyzing data, which allows the reader to gain a deeper understanding of the testing process and the results.

3.1 Project testing at different area and soil surface with terrain class

The powered wheelbarrow was tested in the different area and the results were obtained based on Table 1. The tested load weight for all areas is the same i.e., less than 20kg.

Table 1 Data collection in different area and terrain class

Category of area / Soil surface with terrain class	Clay (Undulating)	Sandy soil (Flat)	Peat (Rolling, undulating)	Cement/tar area (Flat)
Factory area				/
Construction area		/		/
Agriculture area	/		/	

This table describes the results of an experiment that was conducted to test the performance of a wheelbarrow in different types of terrain. The data indicates that the construction area has two types of surfaces: sandy and cement/tar. Both surfaces are characterized as having a flat terrain. The results of the experiment show that the wheelbarrow performed well in this type of terrain when carrying a fixed load weight. The agricultural area, on the other hand, has two types of surfaces: clay and peat. These surfaces are described as having undulating and rolling terrain, respectively. The experiment found that the wheelbarrow performed well in this type of terrain when carrying a load weight of less than 20kg. Lastly, the manufacturing area is only described as having one type of surface, a cement/tar surface, with a flat topography. The experiment found that the wheelbarrow performed well in this type of terrain when conveying a load weight of less than 20kg. Overall, the results suggest that the wheelbarrow performed well in all types of terrain tested, apart from a maximum carrying capacity of 20kg.

3.1 Project testing in different load and soil surface

Table 2 below discusses the data and results obtained from several studies on powered wheelbarrow through differences in surface types according to different load weights. The durability of powered wheelbarrow is assessed through different load weights ranging from <10kg to <70kg.

Table 2 Performance powered wheelbarrow with different soil surfaces and load level

Load limit level (kg) / Soil surface	Clay	Sandy soil	Peat	Cement/tar area
<10	Passed	Passed	Passed	Passed
<30	Passed	Passed	Passed	Passed
<50	Passed	Passed	Unpassed	Passed
<70	Unpassed	Passed	Unpassed	Passed

This table presents the results of a test that evaluated the load limit levels of different types of surfaces and whether the load limit was passed or not. The table shows the load limit levels in kilograms and the different types of surfaces (soil, clay, sandy soil, peat, and cement/tar area) that were tested. The table indicates that for load limits less than 10 kg and less than 30 kg, the load limit was passed on all surface types. However, for load limits less than 50 kg, the table shows that the load limit was passed on sandy soil, clay, and cement/tar surfaces, but not on peat soil. The reason for this is that peat soil surfaces, which are common in agricultural areas, are often composed of a mixture of leaves and twigs, which can make it harder for the wheelbarrow to maintain traction. For load limits less than 70 kg, the table shows that the load limit was passed on sandy soil and cement/tar surfaces, but unpassed on clay and peat surfaces. This is likely because the clay and peat surfaces are more slippery, which increases the load and friction on the wheelbarrow's motor and tires, making it harder for it to move. However, the clay surface does not completely cause problems for the motor to move, as the tires used in this project have good tread and grip.

4 Conclusion

The 'Powered Wheelbarrow' project is a design and manufacturing project that was created to fulfill the requirements of a Bachelor of Electrical Engineering Technology program. Throughout the process of creating this product, the team gained a significant amount of knowledge and expertise in the field of engineering. The collaboration of lecturers and experts who were involved in the development of the Powered Wheelbarrow was crucial in making this project a success. The purpose of this product is to design and build a motorized mechanism for a heavy-duty wheelbarrow, to integrate a brushless motor and a drive mechanism that can move the wheelbarrow, and to evaluate the effectiveness of the powered wheelbarrow under different loads and surface conditions. At the end of this project, the powered wheelbarrow will bring benefits to its users in terms of time, energy, and money. Although it is an innovative product, the benefits will be felt by everyone.

4.1 Recommendation

This sentence highlights some suggestions for improving the weaknesses of a project. The first suggestion is to add a sponge to the handles of the product, as the rubber on the handle is hard and can cause minor cuts on the user's palm. This is especially important when the user is lifting a high load, as the pressure on the handle will be high, and a sponge can help to reduce this pressure. The next suggestion is to improve the design of the product to make it more attractive to buyers. The design of a product is an important factor in attracting the attention of buyers and making it more visually appealing can help to increase its appeal. Another suggestion is to increase security features to protect the user's safety. One way to do this is to add shock absorbers, which are hydraulic (oil) pump-like components that aid in regulating the impact and rebound movement of springs and suspension. Shock absorbers help to keep the tires in contact with the road surface, providing the safest control and brake reaction, and also smooth out bumps and vibrations.

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