Green Transportation: A Low-Cost Electric Bicycle Conversion Project

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***Abstract*—This research project aims to convert a normal bicycle into an electrical bicycle using a motor, motor controller, and several other components. The project is designed to be cost-effective and environmentally friendly, utilizing recycled materials wherever possible. The motor controller is used to regulate the amount of power delivered to the motor and ensure a smooth and efficient ride. The final result is an easy-to-use, low-cost, and eco-friendly mode of transportation. The project has the potential to make a significant impact on the growing market for sustainable transportation options, particularly in areas where traditional modes of transportation are not readily available or affordable. The research demonstrates the potential of combining innovative engineering techniques with sustainable materials to create affordable and efficient solutions to everyday problems**

I. Introduction

Electric bicycles, or e-bikes, have become increasingly popular in recent years due to their eco-friendliness, low cost, and ease of use. However, many people are still hesitant to purchase an e-bike due to their relatively high cost. This research project seeks to address this issue by developing a cost-effective method to convert a normal bicycle into an e-bike using recycled components.

One of the key components of the project is the use of electric brakes for the motor and throttle. These brakes provide a smoother and more precise control over the bike's speed, resulting in a safer and more enjoyable ride. Additionally, the use of electric brakes is more environmentally friendly as they do not release toxic brake dust into the air.

The project also utilizes a geared DC motor of e-bike MY1016Z2. This motor is designed specifically for use in e-bikes and has a high torque output, allowing for efficient and powerful performance. The motor is connected to a motor controller, which regulates the amount of power delivered to the motor based on input from the throttle. This system allows the rider to control the speed of the bike with ease, and provides a smooth and efficient ride.

Overall, this research project demonstrates the potential for combining innovative engineering techniques with sustainable materials to create affordable and effective solutions to everyday problems.

II. COMPONENTS

The following components were used to convert a normal bicycle into an e-bike:

24 Volt DC Geared Motor: The motor used in this project was a 24-volt DC geared motor of e-bike my1016z2. This motor is specifically designed for use in e-bikes and has a high torque output, allowing for efficient and powerful performance.

DC Motor Controller: A DC motor controller was used to regulate the amount of power delivered to the motor. The controller allows for precise control over the motor's speed and power output.

24 Volt Battery: A 24-volt battery was used to power the motor. The battery was chosen for its compact size and high energy density, which allowed for a longer distance on a single charge.

Electric Brakes: Electric brakes were used for the motor and throttle to provide a smoother and more precise control over the bike's speed. These brakes are more environmentally friendly than traditional brakes as they do not release toxic brake dust into the air.

Twist Throttle Grip Accelerator: An electric throttle grip accelerator was used to control the motor's speed. The throttle sends a signal to the motor controller, which then regulates the amount of power delivered to the motor.

Normal Bicycle Freewheel Gear: A normal bicycle freewheel gear was used to connect the motor to the rear wheel of the bike. This gear allows the rider to pedal the bike when the motor is not in use.

Accessories: Various accessories such as cables, connectors, and mounting brackets were used to connect the components together and install them onto the bike.

Overall, these components were chosen for their efficiency, affordability, and environmental friendliness. The combination of the 24 Volt DC Geared Motor, 24 Volt Battery, DC Motor Controller, Electric Brakes, Electric Throttle, Normal Bicycle Freewheel Gear, and accessories allowed for the creation of a powerful and efficient e-bike that is accessible to a wider range of people.

A. DC Motor

The DC geared motor used in this project (MY1016Z2) is a 24-volt motor that is specifically designed for use in e-bikes. The motor is a brush motor, which means that it uses a set of carbon brushes to deliver electrical current to the rotor. The motor has a rated power output of 250 watts and a maximum power output of 450 watts.

The MY1016Z2 motor has a gear ratio of 9.78:1, which allows for a high torque output at low speeds. This high torque output is necessary for e-bikes, as it enables the bike to easily climb hills and tackle other challenging terrain. The motor also has a no-load speed of 2650 RPM, which allows for a maximum speed of around 25 km/h (15.5 mph) when used in an e-bike.

The motor features a simple design with two main components: a stator and a rotor. The stator is the stationary part of the motor and consists of a set of electromagnets that generate a magnetic field. The rotor is the rotating part of the motor and consists of a shaft, a set of permanent magnets, and a set of commutator segments.

When current is applied to the motor, the electromagnets in the stator generate a magnetic field. This magnetic field interacts with the permanent magnets in the rotor, causing the rotor to rotate. As the rotor rotates, the commutator segments in the rotor make contact with the carbon brushes, delivering current to the rotor and maintaining its rotation.

The gear reduction system of the motor further increases the torque output by reducing the speed of the motor and increasing its torque. This reduction in speed allows the motor to deliver high amounts of torque, making it ideal for use in e-bikes.

Overall, the MY1016Z2 DC geared motor is an efficient and powerful motor that is specifically designed for use in e-bikes. Its high torque output and low-speed performance make it an ideal choice for converting a normal bicycle into an e-bike.

TABLE I
DC MOTOR SPECIFICATIONS

Attribute	Value
Model	MY1016Z2
Rated Current(A)	2.2
Voltage(V)	24
Rated Speed(rpm)	3300(before geared) ,360(after geared)
Operating Power(W)	250
Gear Ratio	9.78 : 1
Rated Torque(Kg-cm)	8.15
Min. Reduction Ratio	9.78
Gearbox	Yes
Cable Length(m)	0.5
Weight(Kg)	2.35
Dimensions(cm)	22x15x12

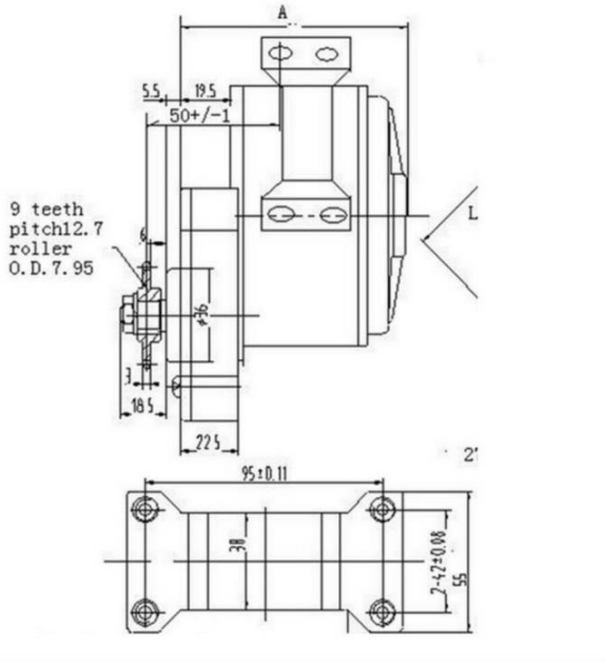

Fig. 1. Dimensions of motor

B. DC Motor Controller

The motor controller used in this project is designed to work with a 24-volt, 250-watt DC geared motor like the MY1016Z2. The controller is responsible for regulating the speed and direction of the motor based on input from the throttle and other sensors.

The motor controller is an electronic device that is placed between the battery and the motor, and it consists of several components, including a microcontroller, power MOSFETs, capacitors, resistors, and a heatsink.

The microcontroller is the "brain" of the motor controller and controls the speed and direction of the motor. It receives input from the throttle, which tells it how fast the motor should be turning, and it adjusts the power delivered to the motor accordingly.

The power MOSFETs are responsible for switching the power on and off to the motor, and they are controlled by the microcontroller. These MOSFETs are designed to handle the high current and voltage levels required by the motor.

The capacitors and resistors help to smooth out the voltage and current delivered to the motor, and they help to prevent damage to the motor and other components.

The heatsink helps to dissipate the heat generated by the MOSFETs, which can get very hot during operation. This heat can cause the MOSFETs to fail, so it's important to have a properly sized heatsink to keep the MOSFETs cool.

Overall, the motor controller is an essential component of an e-bike conversion kit. It allows the rider to control the speed and direction of the motor, and it helps to protect the motor and other components from damage. The controller used in this project is specifically designed to work with a 24-volt, 250-watt DC geared motor like the MY1016Z2, and it provides smooth and reliable performance for an enjoyable and efficient riding experience.

TABLE II
DC MOTOR CONTROLLER SPECIFICATIONS

Attribute	Value
Compatible for Motor	MY1016 250W
Body Material	Aluminium
Cable Length(cm)	10
Current Limit(A)	33
Rated Voltage(V)	24 V DC
Under-Voltage Protection(V)	20 V
Weight(gm)	122
Rated Power(W)	250
Dimensions(mm)(LxWxH)	83x70x38

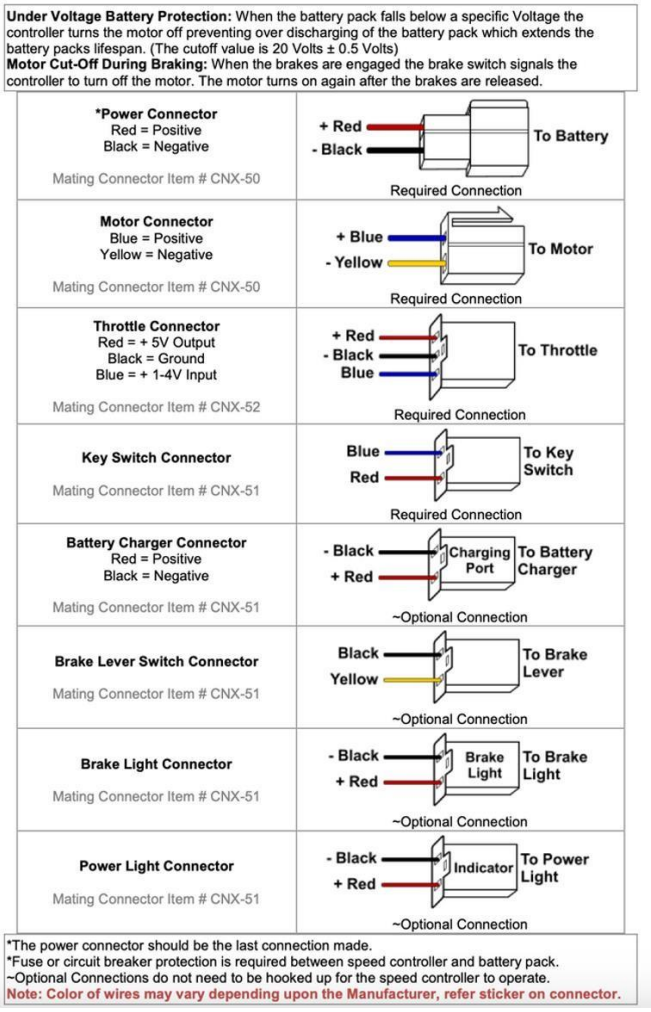

Fig. 2. Connection Diagram

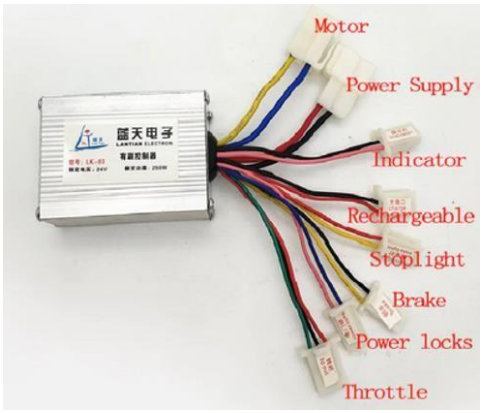

Fig. 3. DC Motor Controller

C. Battery

The battery used in this project is a 24-volt lithium-ion battery consisting of two 12-volt lithium-ion 7Ah batteries connected in series. Lithium-ion batteries are a popular choice for e-bikes due to their high energy density, low weight, and long cycle life.

It's important to monitor the battery voltage and charge it properly to avoid overcharging or over-discharging the battery. It's also recommended to use a battery charger specifically designed for lithium-ion batteries to ensure safe and efficient charging.

Overall, the 24-volt lithium-ion battery used in this project is a reliable and efficient power source for the e-bike conversion kit. It provides a high energy density, allowing for long riding distances, and it is relatively lightweight, making it easy to handle and install. However, without a BMS, it's important to monitor the battery voltage and charge it properly to avoid overcharging or over-discharging the battery.

D. Electric Brakes

The electric brakes used in this project are a key safety feature of the e-bike conversion kit. Unlike traditional mechanical brakes, which use friction to slow down or stop the bike, electric brakes use an electric signal to apply the brakes.

When the rider squeezes the brake lever, an electrical signal is sent to the motor controller, which then applies a braking force to the motor. This regenerative braking system helps to slow down the bike quickly and efficiently, while also recovering some of the energy that would otherwise be lost through friction.

The electric brakes used in this project are typically installed in the front and rear wheels of the e-bike. They are connected to the motor controller, which is responsible for controlling the amount of braking force applied to the motor.

One of the advantages of electric brakes is that they require less maintenance than traditional mechanical brakes. This is because there are no cables or brake pads that need to be adjusted or replaced. Additionally, electric brakes are more responsive and can be controlled more precisely than mechanical brakes.

Overall, the electric brakes used in this project are a reliable and efficient way to slow down or stop the e-bike, while also recovering some of the energy that would otherwise be lost through friction. They are a key safety feature of the e-bike conversion kit and help to ensure a smooth and enjoyable riding experience.

TABLE III
ELECTRIC BRAKES SPECIFICATIONS

Attribute	Value
Color	Silver
Fit handlebar diameter	22mm/0.9”
Fit cable wire diameter	4mm
Total wire length	1.4m
Weight(g)	237
Dimensions(cm)	15x8x3

E. Twist Throttle Grip Accelerator

The twist throttle grip accelerator is a key component of the e-bike conversion kit. It allows the rider to control the speed of the e-bike by twisting the throttle grip, which is located on the handlebars of the bike.

When the rider twists the throttle grip, an electrical signal is sent to the motor controller, which then adjusts the power output of the motor to match the desired speed. This allows the rider to easily control the speed of the e-bike without having to pedal.

The twist throttle grip accelerator used in this project is typically made of durable plastic and is designed to fit comfortably in the rider's hand. It features a smooth, responsive action, which allows the rider to easily adjust the speed of the e-bike as needed.

One of the advantages of the twist throttle grip accelerator is that it provides instant and precise control over the e-bike's speed. This makes it easier to navigate through traffic or handle challenging terrain, as the rider can quickly and easily adjust the speed of the bike to match the situation.

Overall, the twist throttle grip accelerator is a reliable and efficient way to control the speed of the e-bike. It allows the rider to easily adjust the speed of the bike without having to pedal, making it a convenient option for longer rides or when navigating challenging terrain.

TABLE IV
TWIST THROTTLE GRIP ACCELERATOR SPECIFICATIONS

Attribute	Value
Type	Twist Throttle
Inner diameter of handle(mm)	23
Inner total length(mm)	120
Connection	Wire: Red-supply,Black-GND,Green-Signal
Weight(g)	219
Cable Length(m)	1.5
Dimension(cm)	10x8x4

F. Freewheel Gear

The freewheel gear is a key component of the e-bike conversion kit that allows for both electric and manual modes of operation. The freewheel gear is located in the rear wheel hub and is connected to the motor through a chain or belt.

When the rider chooses to pedal the bike manually, the freewheel gear allows the motor to remain stationary and disengaged from the wheel. This means that the rider can pedal the bike without any resistance from the motor, providing a more traditional riding experience.

Conversely, when the rider chooses to engage the motor and use the electric assist, the freewheel gear engages the motor and allows it to drive the rear wheel through the chain or belt. This provides the rider with the desired level of electric assist and helps them to conserve energy during longer rides.

One of the advantages of the freewheel gear is that it allows the rider to switch between manual and electric modes of operation seamlessly. By simply adjusting the throttle or engaging the pedal assist, the rider can quickly and easily switch between modes of operation without having to disengage or remove any components.

Overall, the freewheel gear is a versatile and important component of the e-bike conversion kit. It allows the rider to choose between manual and electric modes of operation, providing a more natural and customizable riding experience.

Fig. 4. Freewheel Gear

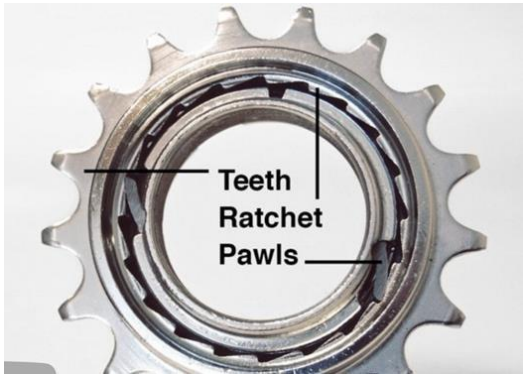

Fig. 5. Inside of Freewheel Gear

G. Accessories

In addition to the main components such as the motor, battery, and controller, several accessories were used in the e-bike conversion kit to ensure a smooth and safe riding experience. These accessories include items such as the wiring harness, connectors, switch, mounting hardware, bracket plate and chain.

The wiring harness is a set of wires and connectors that link the different components of the e-bike conversion kit together. It ensures that the motor, battery, and controller are connected properly and securely, allowing for efficient and safe operation.

Connectors are used to join wires together and ensure a secure electrical connection. These connectors are chosen based on their size and compatibility with the specific components used in the e-bike conversion kit.

A switch is used between the battery and the motor controller for switching and safety purpose.

Mounting hardware such as screws, nuts, and bolts are used to securely fasten the different components of the e-bike conversion kit to the frame of the bike. This ensures that the components are held in place and don't come loose during use.

The e-bike conversion kit used a motor mounting bracket that is specifically designed for the MY1016Z2 24V 250W geared DC motor. The bracket is made of high-strength steel material, ensuring that it can withstand the forces generated by the motor and provide a stable and secure mounting point.

The bracket is designed to be easily installed onto the frame of the bike using the included mounting hardware. The motor can then be attached to the bracket using bolts, which ensure that it remains firmly in place during use.

An additional chain was also used to connect the freewheel gear to the motor. This chain allows the motor to engage with the rear wheel when the rider chooses to use the electric mode of operation. The chain is selected based on the distance between the freewheel gear and the motor and is long enough to provide proper tension.

The motor mounting bracket and additional chain are important components, as they help to ensure that the motor is securely mounted and that the system operates smoothly and efficiently. The bracket is made of high-quality materials, ensuring that it can withstand the forces generated by the motor and provide a secure mounting point. The additional chain is selected based on the specific dimensions of the bike and ensures that the system operates properly.

Overall, these accessories are essential for a successful e-bike conversion project. They help ensure that the different components are connected securely and that the bike is safe and easy to use

III. WORKING

1. Motor and freewheel gear alignment:

The first step in the installation process is to align the motor with the freewheel gear of the bike. This is done by calculating the distance between the two components and then adjusting the position of the motor using the mounting bracket. Once the motor is aligned with the freewheel gear, it can be securely mounted onto the bracket using bolts.

2. Mounting bracket installation:

The mounting bracket is then installed onto the frame of the bike using the included hardware. The bracket is made of high-strength steel material, which ensures that it can withstand the forces generated by the motor during operation. The bracket is designed to provide a stable and secure mounting point for the motor, ensuring that it remains firmly in place during use.

3. Chain cutting and installation:

Next, an additional chain is cut to the required length and installed between the freewheel gear and the motor. This chain allows the motor to engage with the rear wheel when the rider chooses to use the electric mode of operation. The chain is selected based on the distance between the freewheel gear and the motor and is long enough to provide proper tension.

4. Switching between manual and electrical modes:

The e-bike conversion kit allows the rider to switch between manual and electrical modes of operation. In manual mode, the rider pedals the bike as they would with a traditional bicycle. In electric mode, the motor is engaged to assist the rider in propelling the bike forward.

5. Electric brakes:

To ensure that the rider can safely stop the bike in both manual and electric modes, electric brakes are used. These brakes are activated when the rider pulls a lever on the handlebars, which sends a signal to the motor controller to stop the motor. This slows the bike down and brings it to a safe stop.

6. Twist throttle grip accelerator:

The e-bike conversion kit uses a twist throttle grip accelerator to control the speed of the motor. This throttle is installed on the handlebars of the bike and is connected to the motor controller. When the rider twists the throttle, it sends a signal to the motor controller to increase the speed of the motor.

7. Motor controller:

The motor controller is a critical component of the e-bike conversion kit, as it regulates the power output of the motor. The controller is installed between the battery and the motor and receives signals from the electric brakes and throttle. The controller uses this information to regulate the power output of the motor, ensuring that the rider has a smooth and controlled ride.

Overall, the e-bike conversion kit is designed to provide an efficient and cost-effective way to convert a traditional bicycle into an electric bike. The kit includes all the necessary components, including the motor, mounting bracket, additional chain, electric brakes, throttle, and motor controller. With these components, the rider can switch between manual and electric modes of operation and enjoy a smooth and controlled ride.

The motor controller serves as the interface between the motor and the battery, and it is responsible for regulating the flow of electricity to the motor to control its speed and direction.

The 24V DC motor controller that is being used in this project is specifically designed for the MY1016Z2 motor, with a rated power of 250W. It has several ports and connections that must be properly wired to ensure that the system works correctly.

The controller has five main ports labeled as follows:

1. Battery Positive (+) and Battery Negative (-): These ports are where the positive and negative wires from the battery are connected.
2. Motor Positive (+) and Motor Negative (-): These ports are where the positive and negative wires from the motor are connected.
3. Throttle: This port is where the twist throttle grip accelerator is connected. The throttle sends a signal to the controller indicating how much power should be delivered to the motor.
4. Brake: This port is where the electric brake system is connected. When the brakes are applied, the controller receives a signal to cut power to the motor.
5. Power Lock: This port is where a key switch or power lock can be connected to prevent unauthorized use of the system.

In order to connect the motor controller, the positive and negative wires from the battery are connected to the battery ports on the controller. The positive and negative wires from the motor are connected to the motor ports on the controller. The twist throttle grip accelerator is connected to the throttle port on the controller, and the electric brake system is connected to the brake port on the controller.

It is important to note that proper wiring and connections are crucial for the safe and effective operation of the system. Any mistakes or loose connections can result in damage to the components or even injury to the rider. Therefore, it is recommended to follow the manufacturer's instructions carefully and seek professional assistance if needed.

Fig. 6. Complete Cycle and its components

A. Equations

Let the Power of the motor be P and the voltage across the battery terminals be V_P.

The current flowing through circuit is given as *I*.

$$I = P/V_P \quad (1)$$

Let the battery capacity be C (amp-hr).

So , the time (T) in hours is given as :

$$T = C/I \quad (2)$$

IV. Conclusion

In conclusion, the project successfully converted a normal bicycle into an electric bicycle using a geared DC motor, a motor controller, a 24V battery, electric brakes, and a twist throttle grip accelerator. The use of recycled materials helped to keep the cost low while maintaining the overall functionality and performance of the bicycle. With the ability to switch between manual and electrical modes, the rider can enjoy the benefits of both worlds. This project has demonstrated the feasibility and practicality of converting a normal bicycle into an electric bicycle with minimal cost and effort.

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Basic format for electronic documents (when available online):
Issuing Organization. (year, month day). *Title*. [Type of medium]. Available: site/path/file

Example:

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