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Analitical Convert Convensional Car to Electric Vehicle By Electrical Motor BLDC 5KW

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***Abstract*— The automotive industry is experiencing a paradigm shift towards sustainable and eco-friendly transportation solutions. This project aims to contribute to this transition by converting a conventional internal combustion engine (ICE) car into an electric vehicle (EV) using a 5 kW Brushless DC (BLDC) electric motor. The conversion involves replacing traditional engine components with an integrated electric propulsion system. The key components of the conversion include the BLDC motor, motor controller, battery pack, and associated power electronics. The BLDC motor is selected for its efficiency, reliability, and compact design, making it well-suited for retrofitting into existing vehicles. The motor controller regulates the power delivered to the BLDC motor, ensuring optimal performance and efficiency. The conventional fuel system, exhaust system, and other components specific to internal combustion engines are replaced with a battery pack comprising high-capacity lithium-ion cells. This battery pack supplies the necessary energy to the electric motor, with its capacity chosen to meet the range requirements of the converted electric vehicle. The project explores the challenges and solutions encountered during the conversion process, including adapting the vehicle's chassis to accommodate the new components, integrating a charging system, and addressing safety considerations. Additionally, efforts are made to optimize the overall weight distribution and maintain the vehicle's original handling characteristics. Performance testing is conducted to evaluate the acceleration, top speed, and overall efficiency of the converted electric vehicle. The results are compared with the original performance specifications of the conventional car to assess the success of the conversion. This project not only showcases the technical feasibility of converting conventional cars to electric vehicles but also highlights the environmental benefits associated with reducing reliance on fossil fuels. The findings contribute valuable insights to the growing field of electric vehicle conversions and promote sustainable transportation solutions.**

***Keywords*—Converting, Brushless, motor, controller, Battery**

I. Introduction

Emissions from vehicles powered by conventional internal combustion engines represent a significant source of urban pollution [1]. To illustrate the impact, a car consuming 7.8 liters of fuel per 100 km and traveling 16,000 km annually emits approximately 3 tons of carbon dioxide into the atmosphere [2]. Pollution from combustion, including CO2 and NOx gases, contributes to global warming and the greenhouse effect [3].

Addressing the escalating challenge of climate change, electric vehicles (EVs) have emerged as a viable alternative to mitigate greenhouse gas (GHG) emissions and enhance energy security [4]. Converting conventional vehicles into electric ones involves replacing the internal combustion engine with an electric motor and substituting the fuel system with a battery, thereby making it a compelling research topic in the fields of transportation and energy technology. This research presents a significant opportunity to reshape urban transportation patterns, diminish carbon emissions, and foster a more sustainable and environmentally friendly future for mobility.

II. THEORITICAL

A. Air Polution: Air pollution is a significant issue in Jakarta, stemming from various factors such as transportation, population density, land use, and industrialization. The city frequently exceeds national air quality standards, with particulate matter (PM10 and PM2.5) levels among the highest globally [8]. Air pollution entails the emission of harmful pollutants into the atmosphere, posing risks to human health and the environment at large [9]. According to the World Health Organization (WHO), a major contributor is fine particulate matter with a diameter of 2.5 micrometers or less (PM 2.5), capable of deeply penetrating the lungs, heart, and bloodstream, thereby causing diseases, including cancer [10].

B. Electric Vehicle :Electric vehicle holds promise in revolutionizing global transportation for eco-friendly and sustainable mobility, reducing air pollution, greenhouse gases, and health risks [11]. These vehicles lack an internal combustion engine and do not utilize any form of liquid. Fuel Electric cars are powered by batteries in order to operate, these electric cars can reach a range of 160 to 250 km on a full charge. For higher classes, the range can be even further reaching up to 500 km [12]. These mileage ranges are also affected by road condition, driver's age, road condition, climate, and battery type [13].

C. Conversion :Electric cars and conventional gasoline cars differ significantly in their underlying technologies. Electric cars in the same segment typically command an average price that is 50% higher [14]. These electric vehicles utilize costly lithium-ion batteries, which can amount to hundreds of thousands of dollars. Naturally, efforts are underway to reduce the cost of electric cars. One approach is to explore the conversion of internal combustion engine (ICE) vehicles into electric vehicles [15].

The process of converting an ICE vehicle to an electric vehicle involves replacing ICE-related components such as the combustion engine, exhaust system, and fuel tank with EV components like the electric motor, controller, battery, and inverter. Many converters employ an adapter plate to connect the electric motor to the conventional transmission, ensuring seamless power delivery to the wheels [16]. This conversion enables vehicles originally powered by internal combustion engines to transition into more environmentally friendly electric vehicles.

D. Center Of Gravity :The Center of Gravity (CG) of a vehicle is typically positioned at approximately half the vehicle's height. In vehicle design, the CG must be adjusted according to the vehicle's speed as it significantly influences stability, especially on uneven terrain such as slopes and during cornering. The CG is calculated from the lowest point where the vehicle's wheels are attached.

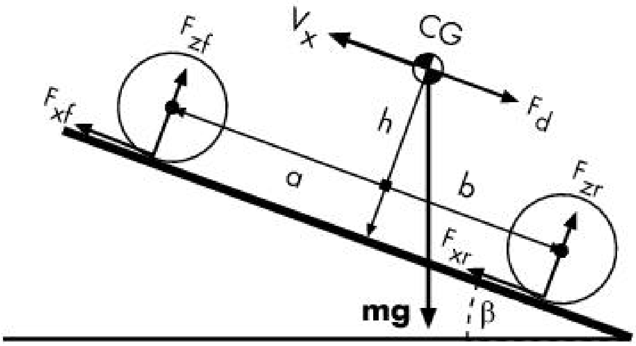

Figure 1 Diagram Gradien

$$h = \frac{F_{z,f}\ (R\ sin\ \beta + a \cos \beta) +\ F_{z,r}\ (R \sin \beta - b \cos \beta)}{mg \sin \beta}$$

Wheel radius (r) = 6,2 cm = 0,062 m

Tire height (R - r) = 45% x 528 mm = 237,6mm = 0,2376m

Total wheel diameter (R)

R = 0,062 m + 0,2376 m

R = 0,2996 m

III. METHODOLOGY

The methodology of electric vehicle conversion can be divided into several stages, namely:

A. Planning : during this stage, the planning of the electric power system for the vehicle is conducted. Various factors are taken into consideration, including the size and weight of the vehicle, required power output, range capacity, and battery charging time. Additionally, the selection of components such as the electric motor, battery, and motor controller is also determined in this phase.

B. Design : at this stage, we will conduct the body and chassis design process of the Kancil car using SolidWorks, while determining the optimal position for its electrical components.

C. Calculate : at this stage the design that has been made is tested and determined the center of gravity to determine the stability of the vehicle at this stage data is needed:

Mmax = Maximum vehicle weight = 830 kg

θ = incline angle = 20°

Wheel Base =2.1m

r = Radian velg = 6,2cm

Wheel high = 25,8cm

IV. RESULTS AND DISCUSSION

Based on the calculations previously conducted, the first step in selecting the appropriate electric motor is determining the required power. In mechanical engineering, power is typically measured in horsepower (hp), where 1 hp equals 746 watts. Therefore, converting the previous internal combustion engine power of 13.5 horsepower to kilowatts (kW) results in approximately 10.071 kW. Based on these calculations, we will now explore the use of a 10 kW hub drive motor.

Figure1. Electric Motor

A. Battery : Battery selection for electric motors is a crucial step in the design that can significantly affect the performance and success of the motor. Key factors to consider include energy capacity, battery type, weight, durability, recharge cycles, and reliability. The decision should be based on a comprehensive evaluation of the needs and intended use of the electric motor. We combined the batteries in parallel to obtain a battery specification of 60V with a current strength of 92A.

B. Controller :The controller is an electronic device that regulates the flow of electricity from the battery to the electric motor, controlling the speed, direction of movement, and efficiency of the vehicle. In this electric car, the controller used is a controller that has been integrated into the electric motor.

C. Design :The design that has been done relates to the placement of electrical components on the Kancil car, which involves the placement and arrangement of components such as electric motors, batteries, and controllers.

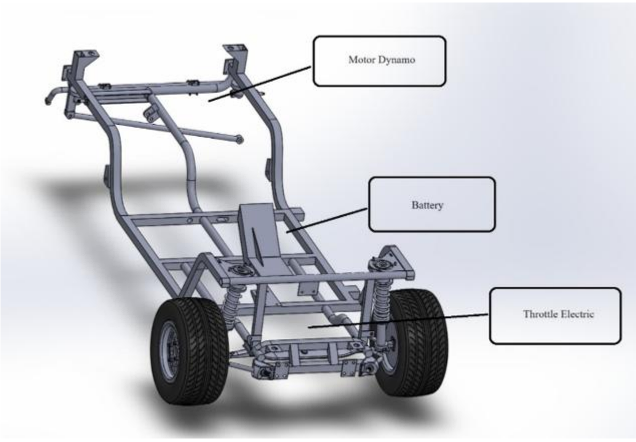

Figure 2. Design Chasis

Employ the SolidWorks software application to meticulously craft the comprehensive body design model of a Kancil automotive vehicle, ensuring precision and accuracy in the digital representation.

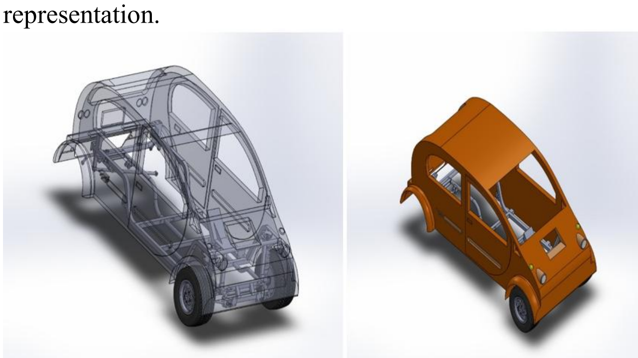

Figure 3. Design Body Vehicle

Control circuit design in electric vehicles has an important role in controlling and regulating various aspects of vehicle performance, including electric motor drive, battery energy management, energy regeneration during braking, and safety and stability systems.

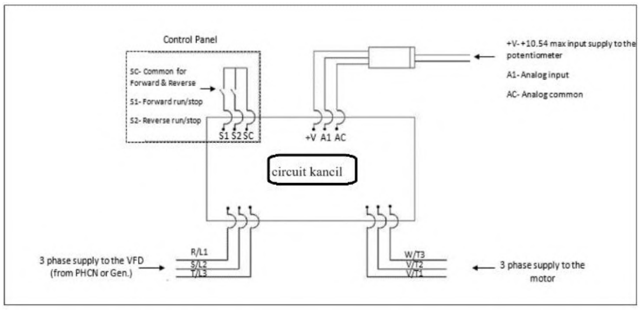

Figure 4 Developed control circuit of the EV

D. Calculate:Center of Gravity, in this calculation, information is needed about the front wheels of the car (F_(z, f)) and rear wheels (F_(z, r)) which can be obtained through the following equation

1. $F_{z,f}$

$$F_{z,f} = 45\% \times m \times g$$

$$F_{z,f} = 45\% \times 830\text{kg} \times 9{,}81\ m/s^2$$

$$F_{z,f} = 3664{,}03\ \text{N}$$

2. $F_{z,r}$

$$F_{z,r} = 55\% \times m \times g$$

$$F_{z,r} = 55\% \times 830\ \text{kg} \times 9{,}81\ \text{m/s}^2$$

$$F_{z,r} = 4478{,}2\ \text{N}$$

From equations (1) and (2) can be obtained the distance from each center of the wheel shaft to the center of gravity. The distance between the center of gravity and the center of the front axle, denoted by a is

$$a = \frac{2l\,F_{z,r}}{mg}$$

$$a = \frac{2 \times 2{,}1\text{m} \times 4478{,}2\ \text{N}}{2(3664{,}03 + 4478{,}2)\ \text{kg} \times 9{,}81\ \text{m/s}^2}$$

$$a = 0{,}11\ \text{m}$$

While the distance between the center of gravity and the center of the rear axle, denoted by b, is:

$$b = \frac{2l\,F_{z,f}}{mg}$$

$$b = \frac{2 \times 2{,}1\text{m} \times 3664{,}03\ \text{N}}{2(3664{,}03 + 4478{,}2)\ \text{kg} \times 9{,}81\ \text{m/s}^2}$$

$$b = 0.096\ m$$

Then determine the center of gravity through the equation h assuming the car is above an inclined plane at a certain β angle. In the above conditions, the car is assumed to be moving uphill at a gradient of $\beta = 20$.

$$h = \frac{F_{z,f}\,(R\sin\beta + a\cos\beta) + F_{z,r}\,(R\sin\beta - b\cos\beta)}{mg\sin\beta}$$

$$h = \frac{3664{,}03\,(0{,}299\,\sin 20° + 0{,}11\,\cos 20°) + 4478{,}2\,(0{,}299\sin 20° - 0{,}096\cos 20°)}{1065{,}996 \times 9{,}81 \times \sin 20°}$$

$$h = 0{,}252 \text{ m or } 25{,}2 \text{ cm}$$

Chasis Testing

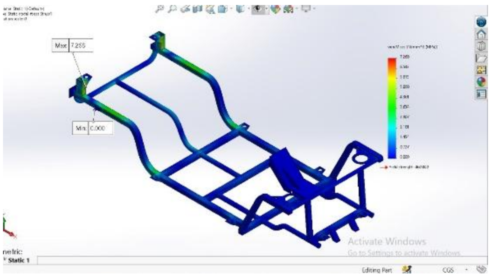

Figure 3. Chasis Testing

The test was carried out using solidwork, where the figure shows that the placement of more weight on the back can still be withstood, give a more detailed explanation.

V. CONCLUSIONS

The conversion of a conventional car to an electric vehicle (EV) using a 5 kW Brushless DC (BLDC) electric motor represents a significant step towards sustainable and eco-friendly transportation. The key components involved in this conversion, including the BLDC motor, motor controller, and lithium-ion battery pack, contribute to the efficiency, reliability, and compact design of the electric propulsion system.

The successful replacement of traditional internal combustion engine (ICE) components with electric alternatives demonstrates the technical feasibility of such conversions. This integration process involves overcoming challenges related to chassis adaptation, implementing a charging system, and ensuring adherence to safety standards. Efforts are also directed towards optimizing weight distribution to preserve the vehicle's original handling characteristics.

Performance testing yields valuable insights into the acceleration, top speed, and overall efficiency of the converted electric vehicle. By comparing these outcomes with the original performance specifications of the conventional car, the success of the conversion can be evaluated, showcasing electric vehicles' potential to equal or surpass the performance of their traditional counterparts.

Furthermore, the significant environmental benefits of reducing reliance on fossil fuels cannot be overstated. This project contributes to the broader objective of mitigating the environmental impact of transportation and aligns with the ongoing paradigm shift in the automotive industry towards more sustainable practices.

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