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Feasibility test of lithium-ion battery system on uwinfly T3 unit with smart battery management system (BMS)

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Abstract

Standard specifications The Uwinfly T3 (T3) electric scooter comes with a 60V 20Ah battery. This battery is known as an SLA battery or dry battery. This battery capacity allows the T3 to travel 50-70 km. Charging time is about 5-6 hours, with 100 Watts power. The T3 motor is a BLDC with 800 watts of power. The T3 can reach a maximum speed of 60 km/h. The purpose of this research is to test the T3 unit using a lithium backup battery with Smart BMS. The method in this study is to first assemble Lithium Iron Phosphate (LFP) 3.2V 15Ah model 32140FS as many as 20 pieces in series so that it becomes a 64V 15Ah LFP battery pack, and JK BD6A20S smart BMS is installed. Second, install the LFP battery pack on the T3 unit as a backup battery using a DC Single Pole MCB. Third, take data on passenger weight, acceleration, mileage, output power and temperature. From the test results conducted using SLA batteries and LFP batteries, the total mileage with 65 kg passengers is 130.2 km, and passengers weighing 130 kg get a total mileage of 123.8 km. Both of the test are using Speed 3 mode.

Keywords

Lithium-ion battery, uwinfly T3, battery management system

Introduction

Electric vehicle technology is currently experiencing a rapid increase, this is in line with environmental issues and global warming in recent years, as well as the Indonesian government's program to accelerate the use of electric vehicles, so that public interest in buying electric vehicles is getting higher [1],[2]. Full-electric and hybrid electric vehicles of various types already exist in the local and international markets. In this research, we try to modify one of the electric vehicle products from Uwinfly, namely T3 (Figure 1).

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Figure 1. Uwinfly T3

Around 2011, the electric vehicle movement started in Indonesia, and the country is still moving toward battery-based electric vehicles [3]. By implementing the first-ever launch of battery-powered electric vehicles on December 17, 2020, this goal was fulfilled. With this public launch, the Presidential Regulation Number 55 of 2019 on the Acceleration of the Battery-Based Electric Motor Vehicle Program for Road Transportation will be more widely implemented, benefiting stakeholders and Central and Regional Government programs.

Li-ion batteries are thought to be the technology that can help lower transportation-related carbon emissions, boost the use of intermittent renewable energy sources, and provide the EU's industry a competitive edge in the Li-ion battery value chain [4]-[7]. Li-ion batteries are recognized as an essential technological advancement that enables the energy shift. To prolong the lifespan of batteries, it is necessary to discharge them periodically. This discharge process should be limited to approximately 10 percent of the entire capacity. It is not advisable to carry out a complete discharge as a regular maintenance procedure, as this can decrease the overall lifespan of the battery [8].

The technology of Lithium-ion offers superior power output, energy conservation, durability, charging speed, and requires minimal upkeep. In addition, supercapacitors enable a more efficient recuperation of energy while braking and descending, and enable a reduction in the strain exerted on the battery. In reality, due to the implementation of energy management, the RMS battery power can be decreased by 90% compared to using a solitary energy source, ultimately enhancing the lifespan of the battery [9].

In comparison to other battery packs within the lithium family, LiFePO4 battery packs or LFP are known for their high energy conversion efficiency, which can reach up to 95%. Additionally, they have a significantly longer life cycle, lasting up to 2000 times as opposed to the typical 400 to 500 times for other lithium family batteries. LiFePO4 battery packs are ideal for powering electric motors and managing power, making them suitable for use in electric scooters, pure electric scooters, hybrid cars, and other applications. In the future, they are expected to become the predominant choice for electric vehicles [10].

Method

Uwinfly T3 Specification

T3 unit used in this research are outlined in Table 1. Additionally, the primary characteristics of T3 can be observed on the website of the producing firm.

Table 1. T3 Specification

Item		Specification
Motor	:	800 Watt
Motor Type	:	BLDC
Battery	:	SLA 60V 20Ah (5x12V 20A)
Dimensions (mm)	:	1.700 x 700 x 1.050
Weight	:	250 kg
Max Load	:	200 kg
Mileage	:	50-70 km
Storage	:	7 liters

LEP battery assembling

Based on the Table 1, storage space on the T3 is approximately 7 liters. We can install additional LFP battery stored in the T3 storage area is 20x20x15 cm. The LFP battery cell we use is model 32140FS as many as 20 pieces assembled in series (20S), and obtained an LFP battery pack with a voltage of 64V and a capacity of 15Ah pack.

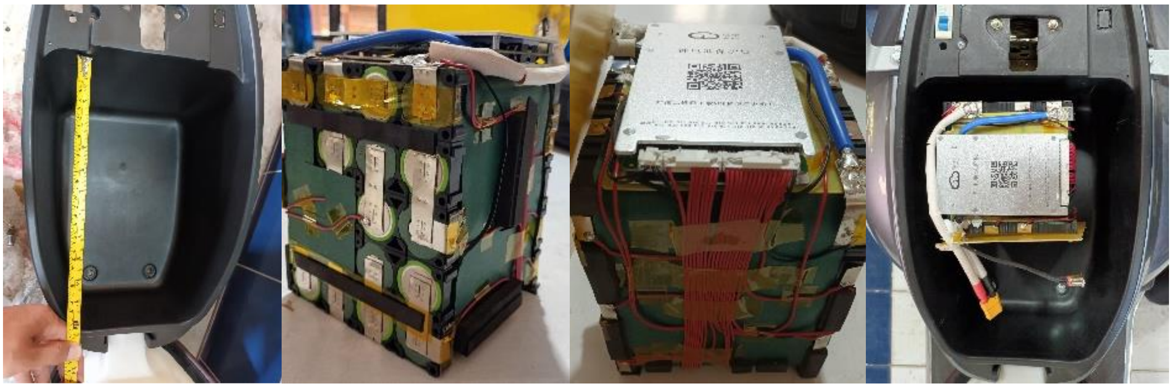

Figure 2. LFP with Smart BMS assembling

LFP battery pack using Jikong JK BD6A24S for active Smart BMS (Figure 2), designed specifically for large-capacity series lithium battery packs is the lithium battery intelligent protection board. Backup voltage collection, big current active equalization, overcharge, over-discharge, and overtemperature protection are among the features. There are also coulomb counters, Bluetooth communication letters, GPS remote controls, and other features. applicable to ternary lithium, lithium iron phosphate, and other battery types.

Installing LFP battery

SLA and LFP batteries are connected with Hager MCB SFT 125 as a switch as well as an MCB, electrical circuits can be seen in Figure 3.

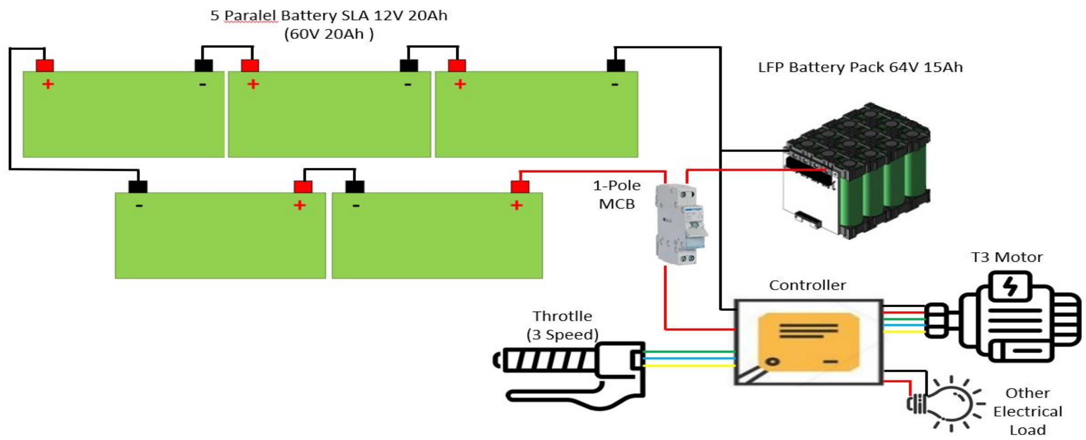

Figure 3. SLA and LFP Assembling on T3 unit

The purpose of this study is to determine the performance of T3 unit using SLA and LFP batteries with two passenger weight variables, with passenger weight of 65 kg and 130 kg. The performance data taken are acceleration, maximum speed, mileage and maximum temp on the battery.

Mileage testing

In the mileage test, T3 is placed on the dynotest and the distance is measured according to the distance indicator on the speedometer. T3 will use 2 batteries alternately, starting with the SLA battery, then when the SLA battery indicator is 80% discharged, the battery source is replaced with LFP with smart BMS until it is 80% discharged. In this research, we will use the commonly used Speed 3 mode to measure mileage test.

Result and Discussion

The experimental results using SLA battery on T3 unit on Speed 3 can be seen in Table 2, and results using LFP battery on T3 unit on Speed 3.

Table 2. Experiment results with SLA Battery 60V 20Ah on Speed 3

Parameters	Value	Unit
Load	65 Kg (1 person)	130 Kg (2 person)
Acceleration (0-100 meter)	10,2 second	12,7 second
Max Speed (km/hour)	58	56
Mileage (km)	68,3	66,4
Max Temp (C⁰)	36,4	45,7

Table 3. Experiment results with LFP Battery 54V 15Ah on Speed 3

Parameters	Value	Unit
Load	65 Kg (1 person)	130 Kg (2 person)
Acceleration (0-100 meter)	10,2 second	12,7 second
Max Speed (km/hour)	56	56
Miliage (km)	61,9	57,4
Max Temp (C⁰)	35,9	43,1

From the two tables above, using SLA batteries and LFP additional batteries, the total mileage with 65 kg passengers is 130.2 km, and passengers weighing 130 kg get a total mileage of 123.8 km. Both of the test, are using Speed 3 mode.

Conclusion

The additional battery used in this study is a lithium battery type LFP model 32140 FS 3.2V 15Ah, as many as 20 pieces, assembled in series and produces a 64V15Ah battery pack, and able to increase the distance by almost 2 times. From the size of the T3 storage, the battery pack capacity can still be expanded up to 20Ah. The active Smart BMS used is the Jikong JK BD6A20S brand, which has the capability of charging-discharging protection, monitoring and providing real-time battery condition data. The default battery condition will be discharged until the remaining battery capacity is 25% and stop discharging at 20%. This feature is to protect the LFP battery from damage and extend the life of the LFP battery.This research may be continued on how to modify and increase performance of electric vehicles with high efficiency.

Acknowledgement

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