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Regenerative Braking System of Electrical Vehicle

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ABSTRACT

With a growing demand for green energy, new technologies are being created to support energy efficiency. Regenerative braking lowers the amount of energy used by electric and hybrid vehicles, improving their efficiency. In electric automobiles, the regenerative braking system recovers some of the kinetic energy lost during braking and transforms it back into electrical energy that may be stored in the battery of the car. This could improve the car's general efficiency and expand its range.

In an electric car with regenerative braking, when the brakes are applied, the electric motor acts as a generator, transforming the kinetic energy of the car into electrical energy. After that, the electrical energy is kept in the car's battery so it may later be used to drive the electric motor.

Regenerative braking has the potential to drastically cut down on energy lost while braking as well as wear and tear on the braking system of the car. Regenerative braking, as opposed to conventional friction brakes, can provide a smoother and more predictable braking feel, which can enhance the entire driving experience. Regenerative braking is used in electric vehicles to expand range, improve energy economy, and improve the driving experience.

KEYWORDS: Arduino Uno R3 Front & back, MG996R Servo Motor, ATmega328, DFU boot loade.

INTRODUCTION

Any moving body can be stopped or have its motion delayed by using brakes. The brakes therefore serve the most crucial purpose in autos. In a traditional braking system, motion is slowed down or halted by absorbing kinetic energy through friction. This is accomplished by bringing the moving body into contact with a frictional rubber pad (referred to as a brake lining), which results in the absorption of kinetic energy and its subsequent loss as heat to the environment. Every time we brake, the momentum the car has gained is absorbed, and we have to start over to regenerate that momentum by utilising more engine power to accelerate the vehicle.Consequently, there will be a significant loss of energy in the end.

These are frequently found in modern electric autos and electric trains. Regenerative brakes are energy recovery devices that slow down moving objects by transforming their kinetic energy into another form that may either be used right away or saved for later use. In electric trains, the generated electricity from braking is therefore put back into the power grid, while in battery- and hybrid-electric cars, the energy is stored in a battery or bank of capacitors for later use. Alternatively, energy can be kept in a rotating flywheel or by compressing air.

The 80 percent of the energy generated is used to counteract the aerodynamic and rolling forces of the road. About 2% of the energy is lost when pressing the brake. Additionally, its brake-specific fuel consumption is 5%. Consider a car that is driven through the main city, where traffic is a serious issue. In this situation, braking regularly is necessary. For such cars, the energy lost when applying the brakes ranges from 60 to 65 percent.

LITERATURE REVIEW

Regenerative braking was first used in 1967 by the American Motors Corporation. Despite being a revolutionary idea designed to increase the vehicle's range, it didn't catch on until hybrid and electric vehicles became popular. Nowadays, the regenerative braking system is part of almost any hybrid or electric car.

According to Siddharth K. 2020 [1], the paper focused mainly on the energy point of view; kinetic energy is surplus energy when the electric motor is in a braking state, which dissipates energy into heat and loses total energy. This wasted energy can actually be converted into useful energy for electric vehicles. Therefore, regenerative braking has been implemented in the automotive braking system to regain wasted energy.

According to Nitish Sharma 2021 [4], electric vehicles are mainly designed to get rid of pollution, use natural fuel, and many other things. In our project, we mainly focused on improving the efficiency of the battery electric vehicle, commonly called BEVs. For this purpose, we used the concept of regeneration of lost energy during braking and stored it in the battery of the vehicle.

PROBLEM FORMULATION

Overall, the literature on regenerative braking systems in electric vehicles highlights the potential benefits of this technology for improving energy efficiency, extending range, and reducing battery degradation. As EVs become more widespread, further research into the optimisation and application of regenerative braking systems will be critical for advancing the state of the art in this area.

This method is one of the ways to improve the mileage because it can increase the mileage of the EV by 8–25%. This technology has replaced traditional vehicle braking systems because most conventional braking systems use a mechanical friction method to always dissipate kinetic energy into heat energy to achieve a stopping effect. Studies show that in urban operations, 1/3 to 1/2 of the energy required to operate a vehicle is consumed during braking. From an energy point of view, kinetic energy is surplus energy when the electric motor is in a braking state, which dissipates energy into heat and loses total energy.

This wasted energy can actually be converted into useful energy for hybrid and electric vehicles. Therefore, regenerative braking has been implemented in the automotive braking system to regain wasted energy. Total energy savings also depend on driving conditions and are generally more effective at low speeds than at high speeds, but braking rarely occurs. Urban drive cycles have a considerable amount of acceleration and deceleration due to traffic control systems in place around towns and cities. Therefore, when decelerating, significant energy is lost. When a conventional vehicle brakes, the energy is lost to heat energy resulting from the friction between the brake pads and wheels.

However, with regenerative braking, this energy can be captured, and 'waste' energy can be harnessed and utilised for vehicle propulsion.

OBJECTIVE OF THE THESIS

- The main objective of the proposed system is to eliminate the traditional braking methodology, which causes a lot of energy waste since it produces unwanted heat during braking.

- Thus, the creation of regenerative braking has overcome these disadvantages; in addition, it helps save energy and provides higher efficiency for a car.

- The main aim that has been focused on is having an influence on brake energy regeneration, which is usable.

ORGANISATION OF THE THESIS

The organisation of a thesis on regenerative braking in electric vehicles may vary depending on the specific focus of the research, but here is a possible outline.

Chapter 1 introduces the background and motivation for the research. Problem statement and research, objectives and scope of the research, methodology, and approach

Chapter 2 presents the literature review, an overview of the existing literature on regenerative braking in electric vehicles, relevant theories and concepts related to the research, Discussion of related technologies and applications, Gaps and limitations in the existing literature

Chapter 3: Design and Implementation Description of the design and implementation of regenerative braking in electric vehicles, technical specifications, and components used

Chapter 4: Presentation and analysis of the data collected from the testing and validation of the system; evaluation of the effectiveness and efficiency of the Campus Surveillance and Assistance Robot in enhancing security measures, increasing efficiency, and providing assistance to students and staff

Chapter 5: Discussion and Conclusion Summary of the key findings and contributions of the research, Implications of the research for educational institutions and security systems Limitations and future directions for the research, Conclusion and recommendations for future research and development

Chapter 6: References: List of all sources cited in the thesis

Chapter 7: Technical details and documentation of the regenerative braking of electric vehicles Additional data and analysis not included in the main body of the thesis

The specific content and structure of each chapter may vary depending on the research question and methodology used, but this outline provides a general structure for organising the thesis.

METHODOLOGY

We are slowly reaching the age of electric vehicles. The major issue behind the mass use of electric vehicles is the battery charging time and the lack of charging stations. So here we propose a regenerative breaking system. This system allows a vehicle to generate energy each time the brakes are applied. The stronger the brakes, the more power is generated. We use a friction lining arrangement in a brake drum. As a drum rotates, the friction lining does not toughen the drum. As soon as brakes are applied, the friction lining touches the drum from inside and moves the motors connected to the lining in the same direction, thus generating electricity using motors as dynamos. Thus, this system allows for charging the car battery each time brakes are applied, thus providing a regenerative braking system. It moves us another step ahead towards a pollution-free transportation system.

Regenerative braking is a special technology used in electric vehicles (EVs) to recover kinetic energy—the energy the car possesses because it is moving—that would otherwise be lost as it slows down or stops when braking. The motor has a reverse gear. A motor functions as a generator while it is running in reverse. The generator transforms kinetic energy into electrical energy to charge the car's battery as the vehicle slows down.

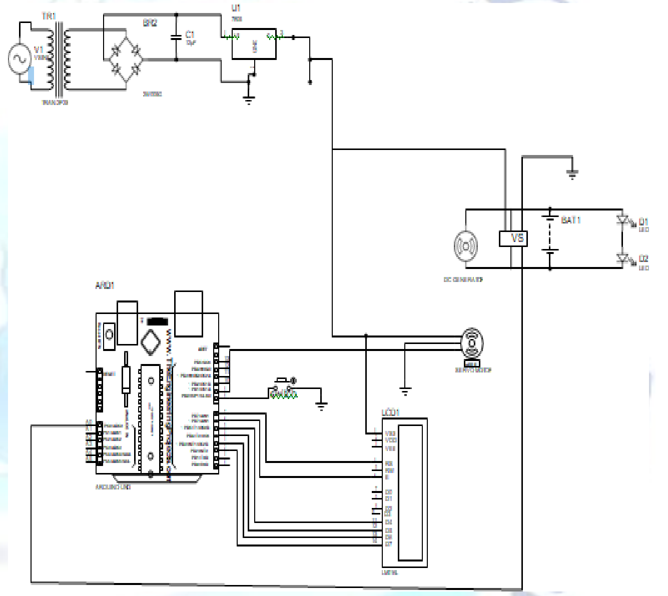

Fig:1 Organizational Diagram

SOFTWARE COMPONENTS

Arduino Uno

Fig:2 Arduino Uno R3 Front   Fig: 3Arduino Uno R3 Back

The Arduino Uno is a microcontroller board based on the ATmega328 (data sheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-Serial driver chip. Instead, it features the Atmega16U2 (and Atmega8U2 up to version R2) programmed as a USB-to-Serial converter.

MEMORY

The bootloader takes up 0.5 KB of the ATmega328's 32 KB of memory. Additionally, it features 1 KB of EEPROM (which can be read and written using the EEPROM library) and 2 KB of SRAM.

INPUT AND OUTPUT

The pinMode(), digitalWrite(), and digitalRead() routines allow you to use any one of the Uno's 14 digital pins as an input or output. They use 5 volts to work. Each pin includes a 20–50 kOhm internal pull-up resistor that is unconnected by default and has a maximum current capacity of 40 mA. Additionally, several pins have specific purposes.

Serial 0 (RX) and Serial 1 (TX): It used to transmit and receive TTL serial data (RX and TX). The ATmega8U2 USB-to-TTL Serial chip's relevant pins are connected to these pins.

2 and 3 External Interruptions: These pins can be set up to initiate an interrupt in response to low values, rising or falling edges, or value changes. Details can be found in the attachInterrupt() function.

3, 5, 6, 9, 10, and 11 PWM: The analogWrite() method outputs an 8-bit PWM signal.

SS: 10 (SS), MOSI: 11, MISO: 12, SCK: 1: The SPI library supports SPI communication on these pins.

LED: 13. Digital pin 13 is wired to a built-in LED. The LED is on when the pin has a HIGH value; it is off when the pin has a LOW value.

Each of the Uno's six analogue inputs, denoted by the letters A0 through A5, offers 10 bits of resolution, or 1024 distinct values. Using the AREF pin and the analogReference() function, the upper limit of their measurement range can be changed from the default range of ground to 5 volts. Additionally, certain pins are designed to do specific tasks:

TWI: pins A4 (SDA) and A5 (SCL). Utilise the Wire library to support TWI communication. Other pins on the board include the following:

AREF: A reference voltage for the analogue inputs is known as AREF. when combined with analog Reference().

Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

ELECTRICAL BLOCK DIAGRAM

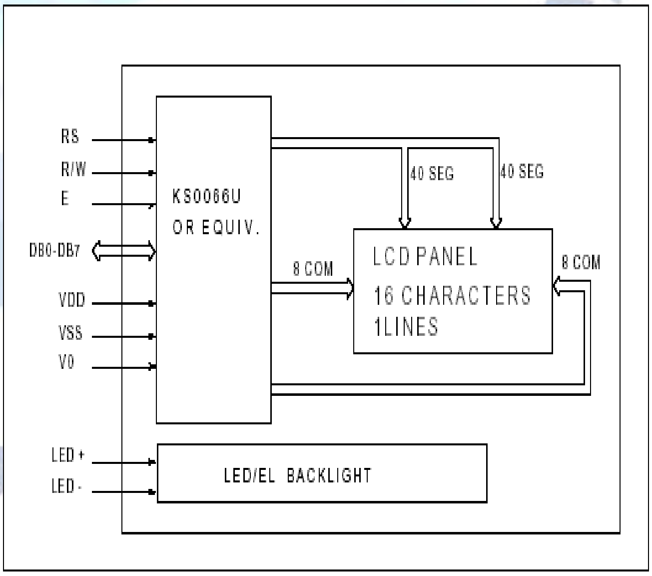

Fig 5 Electrical Block Diagram

PIN DESCRIPTION

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections).

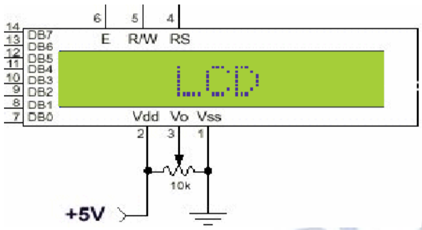

Fig: 6. Pin diagram of 1x16 lines lcd

PIN	SYMBOL	FUNCTION
1	Vss	Power Supply(GND)
2	Vdd	Power Supply(+5V)
3	Vo	Contrast Adjust
4	RS	Instruction/Data Register Select
5	R/W	Data Bus Line
6	E	Enable Signal
7-14	DB0-DB7	Data Bus Line
15	A	Power Supply for LED B/L(+)
16	K	Power Supply for LED B/L(-)

Table 1 Table for LCD

Power Source

All digital circuits need a power supply that is controlled. Learn how to obtain a controlled positive supply from the mains supply in this article.

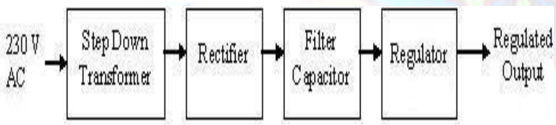

Fig:7 The basic block diagram of a fixed regulated power supply.

TRANSFORMER

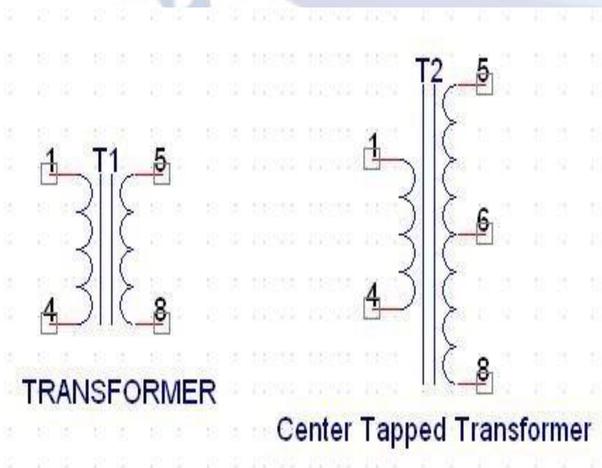

Figure: 8 Structure of Transformer

A transformer is made up of two coils, referred to as "WINDINGS" and labelled as PRIMARY & SECONDARY. Through electrical wires that are inductively coupled and also known as CORE, they are connected. Alternating voltage is produced in the secondary coil as a result of a changing magnetic field in the core brought on by a changing primary current. A load will conduct an alternating current if it is applied to the secondary. In a perfect world, the magnetic field would allow for the complete passage of energy from the primary circuit to the secondary circuit.

$$P_{primary} = P_{secondary}$$

$$I_p V_p = I_s V_s$$

The secondary voltage of the transformer depends on the number of turns in the Primary as well as in the secondary.

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

RELAY

A relay is a switch that is activated and deactivated by another electrical circuit.

In its original configuration, an electromagnet drives the switch to open or close one or more sets of contacts.

A relay can be thought of as, broadly speaking, a type of electrical amplifier since it has the ability to regulate an output circuit that is capable of producing more power than the input circuit.

Fig 9 VOLTAGE RELAY

RELAY OPERATION

A relay typically has five pins, three of which are high voltage terminals (NC, COM, and NO) that connect to the device being controlled.

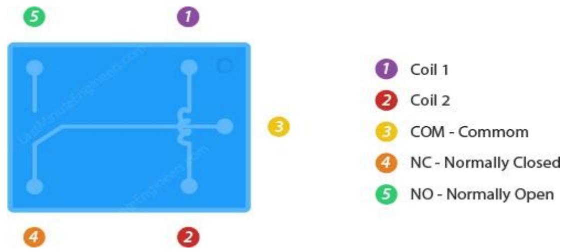

Fig 10 Pin Representation of Relay

Depending on whether the device should remain normally on or off, the connection is made between the COM (common) terminal and either the NC (normally closed) or NO (normally open) terminal.

An electromagnet coil (coils 1 and 2) is located between the two remaining pins.

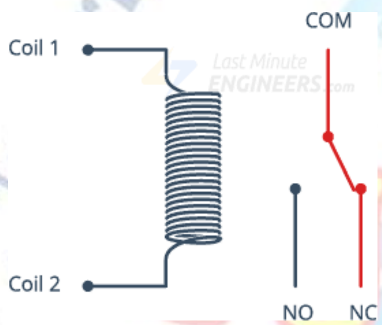

FIG 11 WINDING DIAGRAM

Circuit diagram

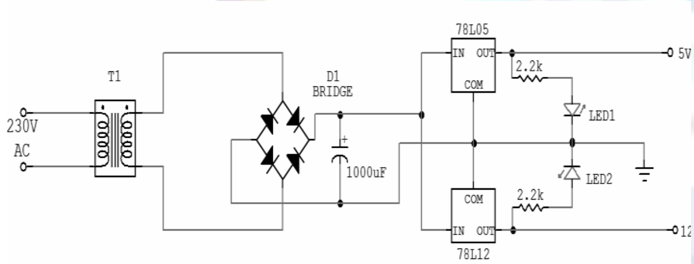

Fig 12 Circuit Diagram of power supply

File

• **New** creates a fresh instance of the editor with just the foundation of a sketch in place.

• **Open** enables loading of a drawing file while navigating through computer drives and folders.

• **Open** Recent Displays a condensed collection of the most recent sketches that are available for opening.

• **Sketchbook** Displays all of the current sketches that are located in the sketchbook folder structure; clicking on any name opens that particular sketch in a new editor instance.

• **Examples**

This menu item displays any example made available by the Arduino Software (IDE) or library. The examples are all organised into a tree that makes it simple to access them by topic or library.

• **Close**

The Arduino Software instance from which it is clicked is closed.

• **Saves** the sketch with the current settings.

• **Save as...**

enables the current sketch to be saved under a different name.

• **Page** Setup Displays the printing Page Setup window.

• **Print** Sends the current sketch, as specified in Page Setup, to the printer.

• **Preferences**

opens the Preferences box, where you can change the language of the IDE interface and other IDE settings.

• **Quit** Closes every window in an IDE. The same sketches that were open when Quit was selected will be opened by default the next time the IDE is launched.

EditUndo/Redo

goes back and undoes one or more editing steps; after undoing a step, you can then redo it.

• Cut

places the selected text in the clipboard and removes it from the editor.

• Copy Copies the editor-selected text and adds it to the clipboard.

RESULTS

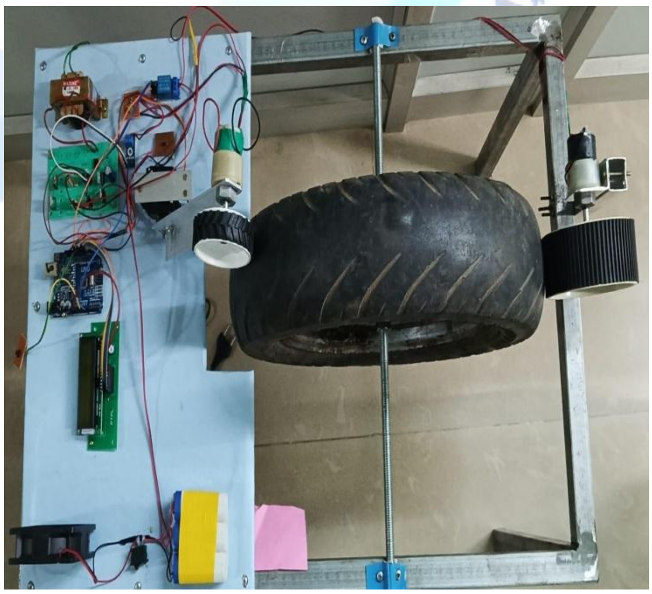

Fig 13 Hardware kit

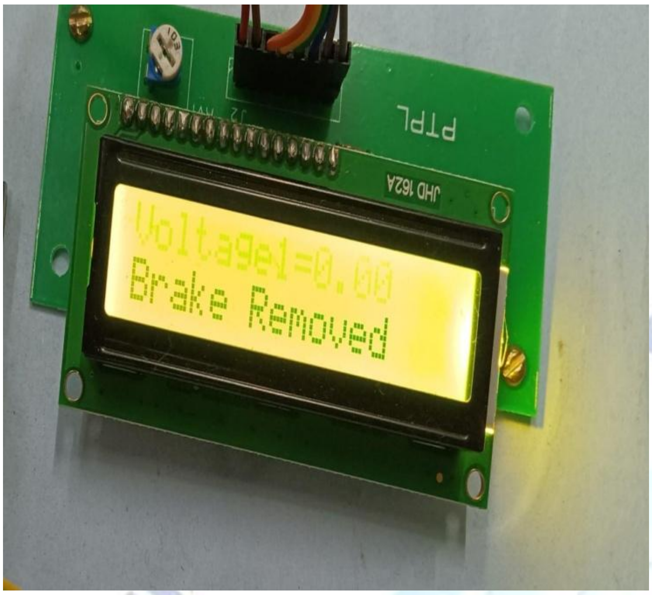

Fig 14 Brake Removed

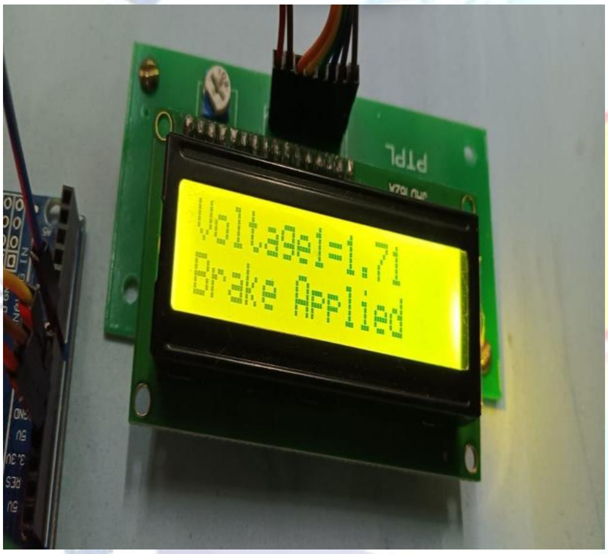

Fig 15 Brake Applied

CONCLUSION

The beginning of the 21st century could very well mark the final period in which internal combustion engines are commonly used in cars. Already, automakers are moving towards alternative energy carriers such as electric batteries, hydrogen fuel, and even compressed air. Regenerative braking is a small, yet very important, step towards our eventual independence from fossil fuels. These kinds of brakes allow batteries to be used for longer periods of time without needing to be plugged into an external charger. These types of brakes also extend the driving range of fully electric vehicles. In fact, this technology has already helped bring us cars like the Regenerative braking allows a vehicle to recover its kinetic energy when braking. Up until now, there have been no systems that fully rely on regenerative braking; however, this paper presents a method to use regenerative braking for all kinds of deceleration. The proposed system allows for a smooth braking experience while also dealing with full-stop and emergency brake situations. The smooth braking experience is achieved by controlling the connection between the generator and its load. Full braking is achieved by using multiple generators, each connected to the shaft with a different gear ratio. This setup ensures that there is always one generator working efficiently and therefore extracting kinetic energy from the system. The overall goal was to design the regenerative braking system while keeping the engineering, producer, and customer models in check.

FUTURE SCOPE

Regenerative braking systems require further research to develop a better system that captures more energy and stops faster. As time passes, designers and engineers will perfect regenerative braking systems, so these systems will become more common. All vehicles in motion can benefit from these systems by recapturing energy that would have been lost during the braking process.

Future technologies in regenerative brakes will include new types of motors that will be more efficient as generators, new drive train designs that will be built with regenerative braking in mind, and electric systems that will be less prone to energy losses.

Of course, problems are expected as any new technology is perfected, but few future technologies have more potential for improving vehicle efficiency than regenerative braking.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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