Automatic Multi-Wheel Drive Kit for Electric Vehicle: A Review

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Abstract: Electric vehicles (EV) have grown in popularity as a result of the desire to reduce carbon dioxide emissions. It's possible that just replacing the internal combustion engine (ICE) with an electric motor isn't the best way to go from conventional to electric automobiles.As a result, innovative system designs such as Four Wheel Drive (4WD) are becoming more popular.Traction and power are the two key advantages of 4WD.This paper provides the review on multi-wheel or four-wheel drive mechanisms for electric vehicle developed in the recent years.

Keywords: Electric vehicles (EV),internal combustion engine (ICE),Multi-Wheel or Four Wheel Drive (4WD).

1. Introduction

Electric vehicles (EVs) offer a wide range of power train options, ranging from one to four electric motors, which can be mounted on the vehicle or in the wheels.Several kinds of production electric vehicles have recently joined the market, with 4WD architectures based on a central motor within each axle, coupled to the wheels through a gearbox, differential, and half-shafts.Parallel to this, a significant body of research and industry demonstrations has focused on two-speed transmission systems for electric vehicles, with the goal of improving longitudinal acceleration and grade ability while increasing the electric power train's operational economy [7].

Advanced motion control systems used on electric vehicles (EVs) with multiple drive trains can help to improve environmental friendliness, driving performance, and active safety, as preliminarily demonstrated with experimental findings in several academic and industrial researches.The following electric drive-train topologies can be used to achieve individual wheel torque control: I in-wheel motors with direct drives; ii) in-wheel motors with mechanical transmissions; iii) on-board motors with transmissions and half-shafts; iv) single on-board motor with mechanical transmission and torque vectoring differential for each axle [8]. Traction and power are the two key advantages of 4WD.In hazardous driving situations such as snow, ice, rocks, and other scenarios where control is difficult, 4WD enhances traction. Traction and control are improved by engaging both sets of wheels. The extra weight helps to improve traction on the road. Off-road enthusiasts will appreciate 4WD.

2. Literature survey

Luming Chen et al. [1] devised a real-time energy management technique that increased the accuracy of load power prediction.Based on an examination of the complete vehicle structure, a mathematical model for each power source was constructed using theoretical analysis and data fitting.The Kalman filter and Markov chain forecasting approaches, as well as a multi-objective optimization function, were employed to design a solution for the joint prediction of non-stationary load power utilizing the nonlinear model predictive control framework.To offer real-time optimal control directives, a sequential quadratic programming method in the finite time domain was applied. Finally, the multi-power source was fine-tuned and synchronized. Multi-road driving trials were conducted using a hardware-in-the-loop simulation platform.According to comparisons of energy management control strategies with and without power prediction, the former improves the predictability of future load power, significantly optimises the coordinated control of multiple power sources, improves vehicle fuel economy, and stabilises bus voltage and battery state of charge.It also has unique reference value in engineering application scenarios under classic model predictive control.

Carlos Montero et al. [2]present a four-wheel-drive electric car that will be used for research. The MATLAB/Simulink framework's Simmechanics is used to generate a dynamic model based on the connection of mechanical components in the vehicle as a CAD model and a simulator. This model has been validated using real-world data, and it may be used to evaluate new torque controllers before they are installed.A real-time control system is installed on the vehicle, which incorporates a torque controller for each of the four motors. The torque that each of the four motors must supply to match the driver's demand is calculated by this control system.Torque distribution control experiments with two and four powered wheels are also included in the study. The tests show how the driver's torque is distributed uniformly throughout the driven wheels, allowing for changing speeds in each of the four wheels as the automobile turns.As a result, the controller embedded in the ECU performs the function of a mechanical differential. The work done shows that, this car may be utilized as an excellent test bed for improved torque distribution controllers.

To increase vehicle agility and reduce energy consumption, Cheng Lin and ZhifengXu [3] offer a multi-objective optimization-based wheel torque distribution technique. Sliding mode control is employed in the high-layer of the presented technique to estimate the appropriate yaw moment due to model imperfection and parameter inaccuracy.In the low-layer, mathematical programming with a penalty function consisting of the yaw moment control offset, the drive system energy loss, and the slip ratio constraint is used for wheel torque control allocation. The programming is done utilizing a combination of off-line and on-line optimization, with the optimization results being provided to motor controllers as torque commands, in order to reduce calculation costs. The presented technique can both increase vehicle agility and minimize energy consumption, according to a co-simulation using MATLAB® and Carsim®.

Xiaogang Wu et al. [4] proposes a dynamic allocation method to realize the torque distribution of an electric vehicle all-wheel drive power system, as well as analyzing and verifying the adaptability of this optimization algorithm in various urban passenger vehicle working cycles, and it is the optimization goal in this research. When compared to the torque average distribution methodology, the simulation results reveal that the proposed method can effectively handle the problem of a discrepancy in efficiency distribution between the two shaft motors in the power system influencing the power system's energy consumption. The suggested method uses 5.96 percent and 5.69 percent less energy than the average distribution methodology for the China urban passenger driving cycle and the Harbin urban passenger driving cycle, respectively.

BrahimGasbaoui and AbdelfatahNasri [5] describe a new assisted steering system and a global torque distribution management system for a four-wheel-independent-drive electric vehicle. The prototype was placed to the test in a range of topology configurations and at high speeds, with the goal of keeping the initial battery state of charge (SOC) at 70%. The system reduces the gap between the actual steering torque and the reference steering torque, which is mapped by vehicle speed and steering wheel position, by applying differential torque between the right and left front wheels. Space vector modulations based on direct torque control improve driving wheel speeds control with high accuracy in curved or slopped roadways, according to simulation data. The driving motors' performance is unaffected by road topological disturbances or driver decisions; on the other hand, the proposed control provides good traction chain dynamic characteristics. This innovative power control DTC-SVM technique, which is based on the features of electric vehicle independent drive, could be applied to four-wheel independent-drive EVs in the future.

Assistance System for Four Wheel Drive Electric Vehicle is presented by K. Sivakumar and Dr. D. Angeline Vijula [6]. The major purpose is to analyses the state of the driving mechanism and automatically convert the driving (2/4 wheel drive) mechanism during start-up, slope conditions, extended driving, and braking times.The parameters in various driving modes, such as 2 wheel, 4 wheel, and automatic drive shifting modes, are also analyzed and compared. Data for various driving modes is captured, and LabVIEW software is used to validate studies for power consumption, efficiency, driving distance, and other aspects.

3. Proposed system

To evaluate the different EV configurations, a nonlinear front looking MatlabSimulink model of longitudinal vehicle dynamics will used. The features responsible for first order torsional drivetrain dynamics are included in both the front and rear axle models: I the halfshafts, which were parametrized to incorporate the torsional compliance of the entire driveline and were modelled as a torsional spring and damper in tandem. ii) the tyres, which were modelled with a relaxation length model using the Pacejka magic formula.

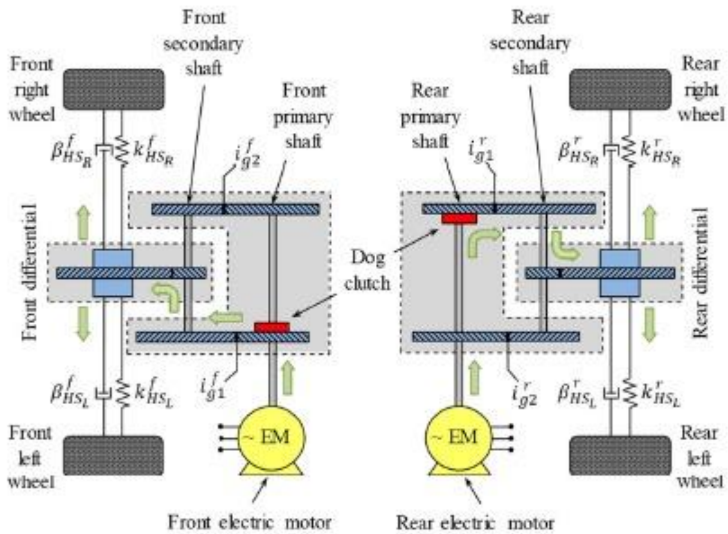

Figure 1 Proposed System

4. Conclusion

In the transportation sector, the electric automobile will play a critical role in reducing carbon dioxide emissions and energy consumption.Traction and power are the two key advantages of 4WD.Traction and control are improved by engaging both sets of wheels. The extra weight helps to improve traction on the road. Off-road enthusiasts will appreciate 4WD. This paper is helpful for the researcher to understand the four-wheel drive mechanisms for electric vehicle developed in the recent years.

References

[1] Luming Chen, Xiaojun Ma, Shuguang Wei, and Dong Yuan, "Real-Time Energy Management Strategy of Multi-Wheel Electric Drive Vehicles With Load Power Prediction Function", IEEE Access, Volume 9, 2021.

[2] Carlos Montero, David Marcos, Carlos Bordons, Miguel A. Ridao, E.F. Camacho, Elena Gonz´alez and Alejandro Oliva, "Modeling and Torque Control for a 4-Wheel-Drive Electric Vehicle", International Conference on Industrial Technology (ICIT), IEEE, 2015.

[3]Cheng Lin and ZhifengXu, "Wheel Torque Distribution of Four-Wheel-Drive ElectricVehicles Based on Multi-Objective Optimization", Energies,Vol. 8, 2015, pp. 3815-3831.

[4] Xiaogang Wu, DianyuZheng, Tianze Wang and Jiuyu Du, "Torque Optimal Allocation Strategy of All-WheelDrive Electric Vehicle Based on Difference ofEfficiency Characteristics between Axis Motors", Energies, Vol. 12, 2019.

[5] BrahimGasbaouiandAbdelfatahNasri, "A Novel 4WD Electric Vehicle Control Strategy Based on Direct Torque Control Space Vector Modulation Technique", Intelligent Control and Automation, Vol. 3, 2012, pp. 236-242.

[6] K. Sivakumar and Dr. D. Angeline Vijula, "Traction Assistance System for Four Wheel Drive Electric Vehicle", International Research Journal of Engineering and Technology (IRJET), Volume: 02, Issue: 09, Dec-2015.

[7] D. Akaho et al. "Development of vehicle dynamics control system forin-wheel-motor vehicle," in JSAE Annual Congress (Spring),Yokohama, Japan, pp. 1-6, 2010.

[8] ValentinIvanov, DzmitrySavitski, Javier Orus, Jose Manuel Rodriguez Fortun, Aldo Sorniotti, Patrick Gruber, "All-Wheel-Drive Electric Vehicle with On-board Motors: Experimental Validation of the Motion Control Systems",IECON 2015 - 41st Annual Conference of the IEEE Industrial Electronics Society, IEEE, 28 Jan 2016.

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