International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

Dual Motor Electric Vehicle (EV) with Torque Vectoring

Uggumudi Divya
Assisstant professor
Electrical and Electronics Engineering Hyderabad Institute of Technology and Management, Hyderabad, India

Narmeta sunitha
UG Scholar
Electrical and Electronics Engineering Hyderabad Institute of Technology and Management, Hyderabad, India

Samreena
UG Scholar
Electrical and Electronics Engineering, Hyderabad Institute of Technology and Management, Hyderabad, India

Thirlangi Sirisha
Assistant Professor
Electrical and Electronics Engineering Hyderabad Institute of Technology and Management, Hyderabad, India

Rayarakula Yashwanth
UG Scholar
Electrical and Electronics Engineering, Hyderabad Institute of Technology and Management, Hyderabad, India

Kodari Swathi
UG Scholar
Electrical and Electronics Engineering Hyderabad Institute of Technology and Management,Hyderabad,India.

Abstract **- This research presents the design and simulation of a two-motor electric vehicle with a torque vectoring control strategy to enhance cornering stability and handling performance. The dual-motor configuration consists of one motor at the left wheels and one motor at the right wheels in order to allow for the independent distribution of torque along the driveline of the vehicle. A torque vectoring and optimizing controller was developed in MATLAB/Simulink where allocation of motor torque is determined using real-time information about driving conditions such as steering angle, yaw rate, and lateral response. The torque vectoring controller application utilizes real-time condition assessment to allocate torque and to utilize the total motor torque available to reduce understeering, oversteering, and overall stability, when cornering. Simulation results show that for an outer-side motor torque allocation, the inner-side motor torque is reduced below general total motor torque capacity to provide stabilizing yaw moments to the vehicle. This is an adaptive torque allocation that maintains vehicle efficiency while adding cornering smoothness and vehicle handling on a variety of dynamic conditions. The torque vectoring for dual-motor electric vehicles is an effective control strategy to promote stable and safe electric vehicle dynamics.**

Keywords - Torque Vectoring, Dual-Motor Electric Vehicle, Cornering Stability, Yaw Control, Simulink Simulation

1. INTRODUCTION

Electric vehicles (EVs) are swiftly becoming the centerpiece of contemporary mobility because of their superior efficiency, lower emissions, and simpler mechanical design. Unlike traditional internal combustion engine vehicles, EVs can produce a wide variety of powertrain designs based on multiple electric motors. This flexibility allows for the ability to control wheel torque independently, which means various vehicle dynamics control strategies can be implemented, such as torque vectoring. Over the past decade, torque vectoring has taken considerable prominence as an effective method to improve vehicle stability, handling, and safety during cornering where maintaining directional proper control is imperative. In a dual- motor EV architecture with a motor on the left and right side of the vehicle, torque paths are separated between the two drivetrains. The EV can in real-time distribute torque between each wheel based on the operating conditions of its limits, road conditions for input, and driver induced steering. Once a difference in torque is created, torque vectoring will induce a corrective yaw moment to enhance performance, and reduce a vehicle's tendency for understeer or oversteer, ultimately enhancing the overall performance on this type of cornering. In comparison to conventional mechanical based differential systems, an electric torque vectoring system is quicker to respond, more precise, and less mechanically complex than traditional gears and clutches. Incorporating sensor feedback, vehicle dynamics modeling and optimization-based control algorithms makes for even more effective torque vectoring.

Every moment or instant, yaw rate, vehicle speed, lateral acceleration, and steering angle information can be measured so that the best torque distribution can be determined for any given vehicle demand, providing stable vehicle performance. In this work, a torque vectoring controller that is designed in MATLAB/Simulink is developed for a dual-motor EV to determine how the torque should be assigned to each left and right motor while the vehicle aligns. The goal of the controller is to improve cornering stability performance by producing more torque to the outer motor and reducing or negatively applying torque to the inner motor produce a stabilizing yaw moment.The results indicate that the system can adjust the torque distribution dynamically to allow smoother cornering, more refined handling, and better trajectory tracking. Furthermore, the suggested control method can reduce excessive slip on all four tires while maintaining the torque distribution equal between the motors, resulting in improvements in efficiency and reduced thermal loads on the powertrain components. In conclusion, this work demonstrates the viability of torque vectoring in dual-motor electric vehicles as an effective method of supplying enhanced driving dynamics, and improved performance, safety, and stability.

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

2. PROPOSED SOLUTION

The proposed solution for the Dual Motor Electric Vehicle with Torque Vectoring focuses on enhancing vehicle performance, safety, and control. The system uses two independent BLDC motors mounted on each wheel axle, allowing precise distribution of torque based on driving conditions. A torque vectoring algorithm continuously processes data from sensors such as wheel speed, steering angle, and road grip to adjust power delivery dynamically. This intelligent control helps reduce understeer and oversteer, improving cornering stability and traction on slippery surfaces. The power supply comes from a high-efficiency Lithium-ion battery pack supported by an advanced Battery Management System for safe and optimized energy usage. Regenerative braking technology is incorporated to convert braking energy back into stored power, increasing the overall driving range. The communication between different controllers and sensors is ensured through a reliable CAN bus system. With real-time motor control and effective energy management, this proposed dual motor EV system provides better stability, improved acceleration, and enhanced driving comfort while maintaining energy efficiency.

3. BLOCK DIAGRAM

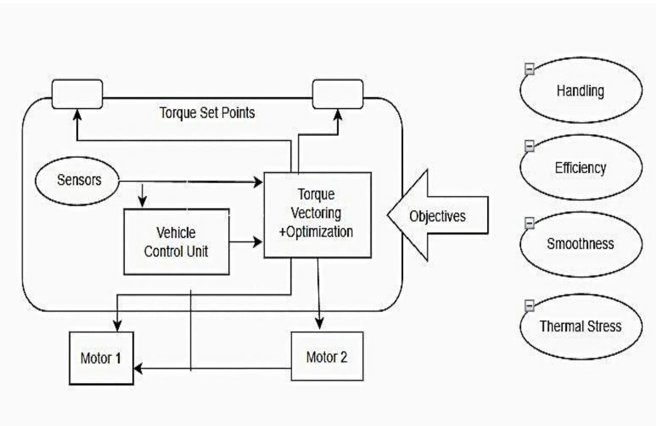

Fig 1.1 Block diagram

The control scheme is depicted in the block diagram for the dual-motor electric vehicle whose controller is equipped with a torque-vectoring scheme. The driver's steering input and accelerator pedal input are processed first to yield the total torque needed and the desired yaw rate. The controller also gets information about the wheel speeds, the yaw rate, and the vehicle acceleration from the vehicle's sensors into the Vehicle Control Unit (VCU), which informs the VCU about the vehicle's state. The controller computes a yaw rate error by taking the actual yaw rate and subtracting, from it, the desired yaw rate based on the steering angle.

The error input is sent to the torque vectoring controller, which computes the necessary torque difference between the left and right motors to stabilize the yaw rate of the electric vehicle when cornering. The torque vectoring controller divides the total torque into left-motor and right-motor commands based on gain blocks and degrees of freedom selected from either optimization based methods. It will provide more torque to the outer wheel of the vehicle to stabilize the cornering and reduce or make the inner wheel torque negative as needed. The motor controllers will then receive the left and right torque commands and actuate the motors.

4. HARDWARE SPECIFICATIONS

A. BLDC / PMSM Motors (Left Motor & Right Motor)

- These are high-efficiency electric motors used to drive each

  side of the EV independently.
- Provide smooth torque production and allow precise control needed for torque vectoring.
- Their response time is fast, helping the controller apply torque corrections quickly during cornering
- They support regenerative braking, which is useful when the inner motor requires negative torque.

B. Motor Controllers / Inverters

- Convert DC battery power into AC power required by BLDC/PMSM motors.
- They regulate motor speed, torque, and direction based on the commands from the torque vectoring controller.
- Enable real-time torque adjustment on each motor independently.
- Provide protection against overcurrent, overheating, and voltage fluctuations.

C. Vehicle Control Unit (VCU) / Microcontroller

- Acts as the central processing unit for torque vectoring logic.
- Reads sensor inputs such as steering angle, wheel speeds, and yaw rate.
- Executes the control algorithms and sends torque commands to each motor controller.
- Ensures the vehicle remains stable by constantly adjusting torque distribution.

D. Inertial Measurement Unit (IMU) / Yaw Rate Sensor

- Measures yaw rate, lateral acceleration, and vehicle orientation.
- Helps determine whether the vehicle is understeering or oversteering.
- Provides critical real-time feedback to the torque vectoring algorithm.
- Improves safety by detecting instability early.

E. Wheel Speed Sensors (Left & Right)

- Measure rotational speed of each wheel to detect slip or traction loss.
- Used in torque vectoring to determine which wheel needs more or less torque.
- Provide accurate real-time vehicle speed estimation.
- Work in coordination with IMU to enhance stability control

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

-

F. **Battery Pack (DC Supply)**

- Supplies electrical power to both motors and motor controllers.
- Provides stable voltage for consistent torque output.
- Stores energy recovered from regenerative braking.
- Determines overall range and performance of the EV.

G. Power Distribution Unit (PDU)

- Manages the safe distribution of electrical power from the battery to all components.
- Includes fuses, relays, and protection circuits.
- Prevents overload and short-circuit conditions.
- Ensures clean and reliable power delivery to the motors and controllers.

5. WORKING

The dual-motor torque vectoring system that is proposed in this research will be designed and tested in a MATLAB/Simulink simulation environment. The architecture will consist of a dual-motor electric vehicle (EV), with one motor connected to the left wheels of the vehicle, and one connected to the right wheels. Vehicle dynamics parameters, such as yaw rate, lateral acceleration, steer angle, and wheel speeds, will be obtained from virtual sensors. The virtual sensors will report inputs to the Vehicle Control Unit (VCU), which will determine the wanted yaw behavior of the vehicle, based on the driving conditions. The vehicle controller and torque vectoring and optimization algorithm will then calculate the desired torque split to create stability in the cornering. To simplify the test, the total torque available to the engine will be set as a constant input to the simulation. The controller will then adjust the left and right motors' torque commands independently. The test scenario will apply the appropriate torque difference in order to develop a corrective yaw moment to improve vehicle stability. Each scenario will test the vehicle's cornering at different yaw rates, while monitoring torque values and the overall vehicle dynamics and behavior. The torque profiles and dynamics will be documented and analyzed to develop accurate measures of handling performance and confirm controller effectiveness.

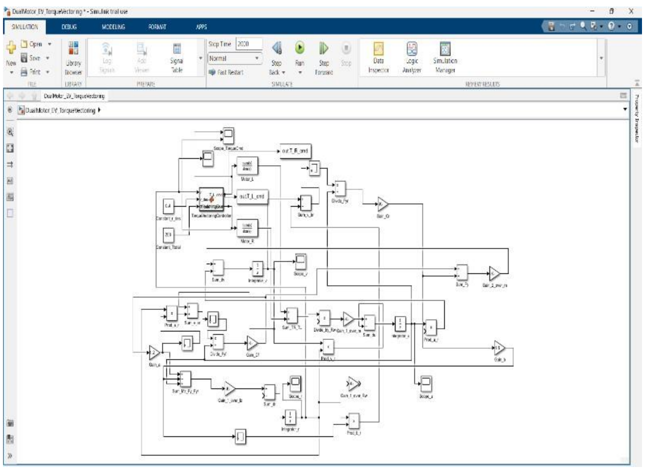

Fig.4.1: Dual Motor with torque vectoring

6. RESULT

The simulation results provide clear evidence of the efficacy of the dual-motor torque vectoring approach in MATLAB/Simulink. The control algorithm continuously received feedback from the yaw rate, steering angle, and wheel speed inputs in order to compute the delicate

handling of an electric vehicle relative to cornering. By independently controlling the torque of the left and right motors, the controller successfully produced corrective yaw moments that minimized both understeering and oversteering. According to simulated results, the outer wheel torque was consistently driven higher, while the inner

wheel torque was reduced, or even driven negative to stabilize the vehicle dynamics. The system exhibited smooth response characteristics accurately corresponding to the changes in steering input and vehicle dynamics, leading to predictable and stable cornering behavior. To conclude, this work finds that torque vectoring is an effective and practical method for improving safety, control, and dynamic performance of dual-motor electric drivetrains.

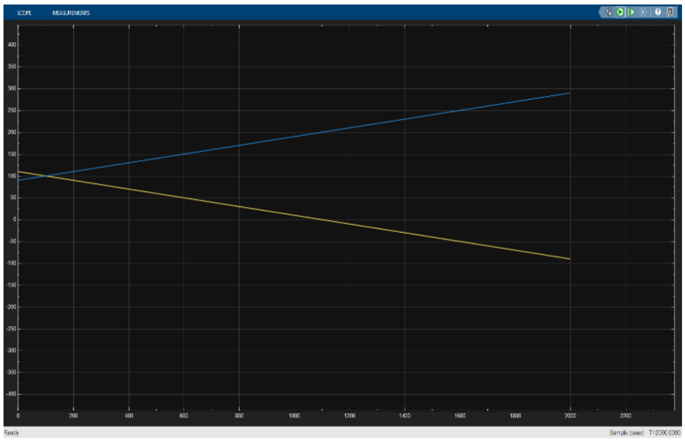

Fig.4.2: Right wheels torque vs Left wheels torque

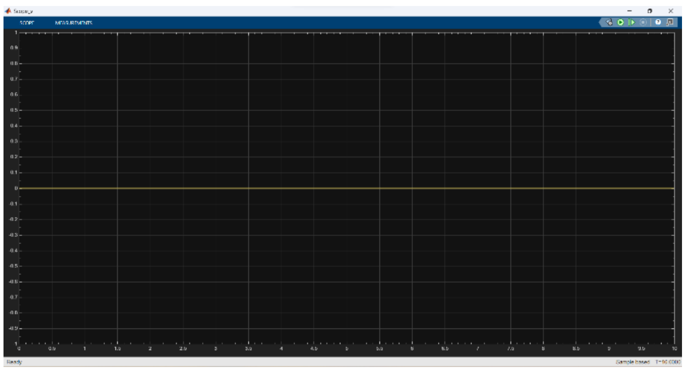

Fig.4.3: Acceleration given to the two motor

(This work is licensed under a Creative Commons Attribution 4.0 International License.)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

6. CONCLUSION

The dual-motor torque vectoring system that was developed in this project effectively demonstrated its ability to improve the stability and torque split necessary for stable cornering. The results divulged that upon a vehicle executing a turn, the torque applied by the outer-side motor significantly ramped from the base torque of 100 Nm to upward of 280–300 Nm, with the inner-side motor torque response negatively down trending to as low as –100 to –150 Nm in some occasions. The negative torque denoted controlled regenerative braking which aided in producing a corrective yaw moment to stabilize the vehicle. The torque curves were smooth and responsive while congruent with expected vehicle behavior in both left and right turning cycles. The simulation also provided evidence that the controller would react in real-time as the driving condition changed producing effective torque transfer throughout the maneuver.The outcomes support that torque vectoring controller improved overall vehicle handling and stability of the dual-motor electric vehicle. The overall insufficiency of understeer and oversteer was managed successfully by modifying torque locations from the left and right motors actively, especially sharper, higher speed turns would predicate a demand for improved response. Consistent torque transfer to the outer wheel improved cornering.

7. REFERENCES

[1] M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles*, 2nd ed., CRC Press, Boca Raton, FL, 2018.

[2] R. Rajamani, *Vehicle Dynamics and Control*, 2nd ed., Springer, New York, NY, 2011.

T. D. Gillespie, *Fundamentals of Vehicle Dynamics*, SAE International, Warrendale, PA, 1992.

[3] MathWorks, “Vehicle Dynamics Blockset Documentation,” Natick, MA, 2024. (Online). Available: MATLAB/Simulink Documentation.

[4] S. D. S. Choi and H. Peng, “Active Steering and Torque- Vectoring Control for Vehicle Stability – A Review,” *Journal of Automobile Engineering*, vol. 230, no. 2, pp. 123–145, 2016.

[5] A. S. Al-Ali and M. T. Masri, “Torque Vectoring Control Strategies for Electric Vehicles: Comparative Study and Simulation,” *International Conference on Automotive Control and Electric Drives*, pp. 45–51, 2019.

[6] K. J. Astrom and R. M. Murray, *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton University Press, Princeton, NJ, 2008

(This work is licensed under a Creative Commons Attribution 4.0 International License.)