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Design and Development of a Dual Motor Electric Vehicle with Torque Vectoring Control

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Abstract

The goal of this project is to build and test a dual-motor EV prototype with a torque vectoring system to make it more stable, give it better traction, and improve its overall driving performance. This project goes beyond just simulating the work; it also includes real-time hardware implementation with an embedded control system. The system has two motors that can be controlled separately. This means that the torque can be split between the left and right wheels depending on the road conditions. A Vehicle Control Unit that uses a microcontroller takes inputs like steering and wheel speed and figures out how much torque each motor should get. The system helps the car turn more smoothly and cuts down on problems like understeer and oversteer by changing this torque difference. The prototype has important parts like motor drivers, sensors, and a power supply that show how torque vectoring works in real life. To keep the system stable and make sure that torque changes happen smoothly, basic feedback control is used. Tests show that this setup is easier to handle, turns more smoothly, and has better traction than a single-motor setup. In general, this project shows that torque vectoring can work in a real system, which is a good start for future electric vehicles and self-driving cars.

Keywords: *Torque Vectoring, Dual-Motor Electric Vehicle, Cornering Stability, Embedded System Control, Vehicle Stability and Traction.*

1. Introduction

Because of there efficiency, produce very little pollution, and are less complicated to build, electric vehicles (EVs) are becoming a big part of modern transportation. Unlike regular cars with internal combustion engines, electric vehicles (EVs) have more options for how to design their powertrains, especially when they use more than one electric motor. This makes it possible to use advanced control methods like torque vectoring, which lets you change the torque on each wheel separately to make the car work better. Torque vectoring has become more important as a way to improve vehicle stability, traction, and handling, especially when turning and driving in dynamic conditions. With a dual-motor EV system, you can control each motor separately. This means you can change the torque in real time based on things like steering input, wheel speed, and how the car is moving. The system makes a corrective yaw moment by changing the torque between the left and right wheels. This helps reduce understeer and oversteer, which makes the vehicle behave more smoothly and stably. This project uses a hardware-based method to design and build a dual-motor torque vectoring system. A microcontroller-based Vehicle Control Unit (VCU) takes in sensor data and uses control logic to figure out how much torque each motor should get. This study emphasizes real-time operation with physical components, including motors, drivers, and sensors, in contrast to simulation-only studies. The goal of this project is to show how torque vectoring can be used in real life to make vehicles safer, more comfortable to drive, and better at handling. This prototype is a step toward better electric vehicle control systems and smarter ways to get around in the future [1].

2. Proposed Solution

The proposed solution is to make a prototype of an electric vehicle with two motors and a real-time torque vectoring system to make the vehicle more stable, improve traction, and overall performance. This system is different from simulation-based systems because it uses hardware parts that are connected through a microcontroller-based control unit. The prototype has two motors that can be controlled separately, one on each side of the vehicle. With this setup, you can control the torque distribution between the left and right wheels very accurately and in real time. A microcontroller-based Vehicle Control Unit (VCU) is the main controller of the system. It gets information from sensors like wheel speed sensors and steering input, and then it uses that information to figure out how much torque each motor needs. The VCU has a control algorithm that uses the difference between the desired and actual behavior of the vehicle to figure out the torque difference (ΔT). When turning, the system adds torque to the outside wheel and takes it away from the inside wheel. This creates a corrective yaw moment that makes the car more stable and less likely to oversteer or understeer. Motor drivers are used to control the amount of power that each motor gets based on the control signals that the VCU sends. There is also a power supply unit and a basic feedback system in the system to make sure it works smoothly and steadily. This hardware-based implementation shows how torque vectoring can be done in real time, which makes driving easier, gives you better traction, and gives you more control over the car. The suggested system is a useful and scalable answer for advanced electric vehicle uses [2].

3. 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 [3]. 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 Shown in Figure 1.

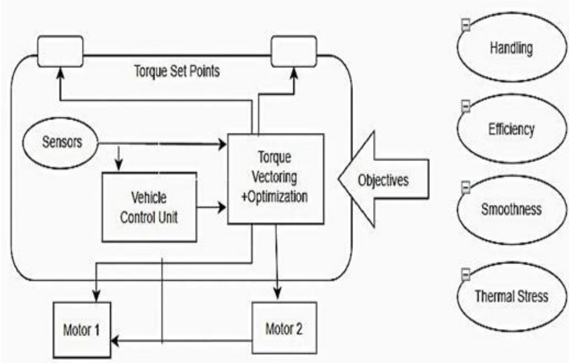

Figure 1 Block Diagram

4. Hardware Specifications

4.1. Microcontroller Board (Arduino Uno)

- Visible at the top section of the chassis
- Acts as the Vehicle Control Unit (VCU)
- Processes control signals and sends commands to motor drivers [4]
- Interfaces with Bluetooth module and control circuitry Shown in Figure 2

Figure 2 Arduino Uno R3 Microcontroller Development Board

4.2. Bluetooth Module (HC-05 / HC-06)

- Used for wireless control via mobile phone (seen in video) [5]

- Receives commands like forward, left, right
- Sends data to the Arduino for processing Shown in Figure 3

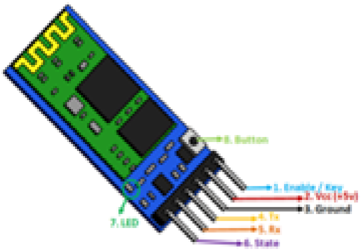

Figure 3 **HC-05 Bluetooth Wireless Communication Module**

4.3. DC Geared Motors (4 Motors)

- Four wheels with individual DC geared motors
- Provides sufficient torque for movement and turning [6]
- Likely paired (left side vs right side) for differential control Shown in Figure 4

Figure 4 **DC Geared Motor with Wheel Assembly**

4.4. Motor Driver Module (L298N or similar)

- Clearly visible with heat sink and wiring
- Controls speed and direction of motors
- Receives signals from Arduino [7]
- Enables left-right torque variation (basic torque vectoring) Shown in Figure 5

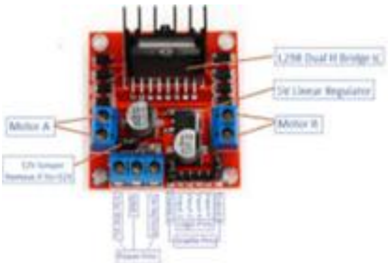

Figure 5 **L298N Dual H-Bridge Motor Driver Module**

4.5. Battery Pack (Li-ion Cells)

- Cylindrical cells mounted at center of chassis
- Supplies power to motors and electronics [8]
- Secured using strap (green band visible) Shown in Figure 6

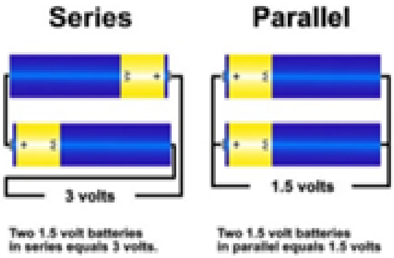

Figure 6 **Series and Parallel Battery Connection Configurations**

4.6. Custom Control Circuit Board

Small PCB with:

- LEDs (status indication)
- Capacitors and resistors [9]
- Possibly voltage regulation or signal conditioning Shown in Figure 7
- Helps stabilize and distribute signals

Figure 7 **LM2596 DC-DC Step-Down (Buck) Voltage Regulator Module**

4.7. Chassis (steel Base Platform)

- Rectangular steel board used as base
- Holds all components securely
- Provides structural support Shown in Figure 8

Figure 8 **Robot Chassis Enclosure (Metal Frame)**

4.8. Wiring & Connectors

- Jumper wires connecting all modules

Ensures communication between:

- Arduino
- Motor driver
- Bluetooth module
- Power supply

5. Working

The prototype is based on dual-motor diagonal drive system. Two DC motors are mounted diagonally on the vehicle. One motor is placed on front-left wheel and the other on rear-right wheel. The remaining wheels serve as passive support wheels. This system can be used to show torque vectoring behavior with minimal hardware complexity. The process starts with mobile phone being used as control interface. Mobile phone sends command for forward, backward, left and right movement through Bluetooth application. The Bluetooth signals are received by Bluetooth module (HC-05/HC-06) and sent to Arduino microcontroller which is used as Vehicle Control Unit (VCU). Microcontroller receives these signals and generates control signals for motor driver module (L298N). Motor driver receives these signals and regulates speed and direction of two motors by PWM signals. When moving forward, the two motors are driven in the same direction at approximately the same velocity, which results in balanced force and straight line movement. When turning, however, the controller causes the two motors to have a difference in velocity. For a right turn, for example, the motor on the one diagonal is slowed, and the other is maintained or increased. This causes a difference in forces across the vehicle, which results in a yawing type of movement, causing the vehicle to turn. The fact that the motors are located on diagonal opposite sides of the vehicle causes the resulting forces to be across the vehicle body, which results in a torque vectoring type of effect. In this way, a simple hardware arrangement has been shown to produce differential torque control to affect vehicle direction. The vehicle is powered by a battery pack, and all of the parts are mounted on a chassis that allows for stability and proper alignment. In sum, the prototype has displayed that torque vectoring can be achieved with smooth movement, controlled turning, and good handling Shown in Figure 9 & 10.

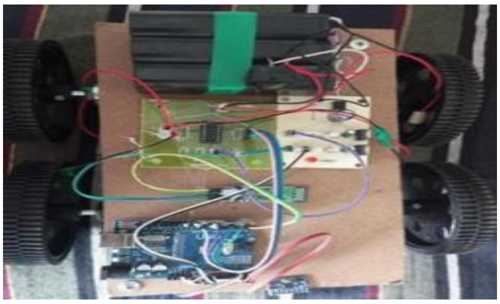

Figure 9 Prototype

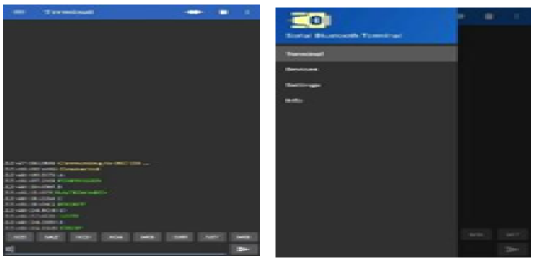

Figure 10 Commands given to the Prototype

6. Result

Feedback on Control System and Vehicle Prototype. The electric vehicle with torque vectoring was tested by experimental prototype to obtain the real-time performance, control response, and vehicle maneuverability. The prototype system that has two DC motors located at diagonal and controlled by a microcontroller successfully illustrated the concept of torque vectoring and differential motor control. The prototype responded well to the commands issued by the mobile device through the Bluetooth interface. The communication between the mobile and the microcontroller was stable with low delay. The microcontroller properly interpreted the control signals and provided the correct PWM output signals to the motor driver. When the vehicle was moving in straight-line, the two motors were controlled at the same speed. The vehicle moved forward with a stable and uniform speed. The vehicle did not drift during the motion. In turning maneuver, the vehicle is turning in desired direction by differential control. When the one of the two motors is reduced in speed and the other kept or increased, it creates torque imbalance along the vehicle body. This imbalance along the vehicle body caused yaw motion so the vehicle is turned in desired direction smoothly. The vehicle is not jerked or plumped during turning motion. It starts from an initial condition and accelerates gradually and smoothly to a desired speed and toward a desired direction. The diagonal arrangement played an important role for rotating the vehicle. With this arrangement, unlike the conventional arrangement where the two motors are at left and right, forces are distributed over the vehicle frame, but the same work is done by varying the torque. It is found to be not as efficient as the conventional arrangement, but the working principle has been effectively demonstrated. The response of the motor driver module to the PWM signal is quite fast and the motors are accelerated/decelerated smoothly. The electronic components and power supply performs in a stable manner as the system is tested repeatedly. The prototype was tested on flat ground, observing good traction and stability. Nevertheless, due to the lack of feedback sensors (such as IMU or wheel encoders), the controller is not in closed loop, but in an open-loop command-based torque vectoring implementation. In conclusion, the experimental results show that even with a diagonal motor layout, independent control of two motors is enough to generate torque imbalance and yaw motion. The prototype shows the feasibility of the basic idea of torque vectoring, improved controllability and reduced mechanical complexity, serving as a basis for real-time control of electric vehicles.

Conclusion

This project has effectively designed and implemented a dual-motor electric vehicle prototype with torque vectoring capability using hardware-based approach. By employing two independently controlled DC motors positioned diagonally, the system achieved differential torque generation and yaw movement, allowing for smooth and controlled vehicle turning. The microcontroller-based Vehicle Control Unit (VCU) successfully processed user commands sent through the Bluetooth interface and generated the corresponding Pulse-Width Modulation (PWM) signals for controlling motor speed and direction. The prototype exhibited stable straight-line motion, responsive turning, and predictable performance across various tests. Although lacking sophisticated feedback sensors, the project successfully demonstrated a command-based torque distribution approach that embodies the essence of torque vectoring. The diagonal motor configuration allowed for a streamlined design while maintaining effective maneuverability and directional control. Overall, this project demonstrates the potential of independent motor control to enhance vehicle handling with minimal hardware complexity, providing a practical stepping stone for future advancements in electric vehicle control systems and intelligent mobility technologies.

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.
[3]. T. D. Gillespie, Fundamentals of Vehicle Dynamics, SAE International, Warrendale, PA, 1992.
[4]. MathWorks, “Vehicle Dynamics Blockset Documentation,” Natick, MA, 2024. (Online). Available: MATLAB/ and Simulink Documentation., 2024. [Online]. Available: https://www.mathworks.com
[5]. 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.
[6]. A. S. Al-Ali and M. T. Masri, “Torque Vectoring Control Strategies for Electric Vehicles: A Comparative Study and Simulation,” International Conference on Automotive Control and Electric Drives, pp. 45–51, 2019.
[7]. K. J. AstromÅström and R. M. Murray, Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press, Princeton, NJ, 2008
[8]. “Speed Control of BLDC Motor using Fuzzy Logic Controller,” IEEE Conference, 2016.
[9]. “Regenerative Braking System for Electric Vehicles using BLDC Motor,” IEEE Transactions on Vehicular Technology, 2016.