Automated Secondary Load Reduction in EVs for Uphill Torque Enhancement

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ABSTRACT -This research focuses on the design and manufacturing of a smart electric vehicle that automatically shifts power transmission between the internal system and wheels using a gyroscopic sensor and a microcontroller. As the era of electric vehicles begins, it is set to revolutionize the automobile industry by replacing fossil-fuel-powered vehicles. These eco-friendly vehicles significantly reduce harmful emissions. The objective of this project is to develop a smart car with an automatic power-shifting mechanism. The mechanical design will be created using SOLIDWORKS (CAD), and the system will incorporate a 12V regulated power supply, a wiper motor, a fan, and an ATmega-328P microcontroller. A comparative analysis will be conducted to evaluate experimental and analytical results, leading to meaningful conclusions.

Keywords: *Automatic power, embedded, Energy distribution, Gyroscope, High altitude*

1. INTRODUCTION

An electric vehicle (EV) uses one or more electric motors for propulsion, powered by batteries, solar panels, or external electricity sources. EVs include cars, buses, trains, ships, and even spacecraft. While early electric cars gained popularity in the 1880s, they declined due to the rise of internal combustion engines. However, since 2008, EV adoption has surged due to battery advancements, environmental concerns, and government incentives. Compared to gasoline vehicles, EVs are quieter, produce no tailpipe emissions, and offer lower overall emissions depending on the electricity source. A gyroscope is a device that measures or maintains orientation and angular velocity. Used in navigation systems, aerospace, and consumer electronics, gyroscopes help with stability and direction in vehicles, submarines, and spacecraft. A microcontroller (MCU) is a compact computer on a chip, integrating a processor, memory, and input/output functions. MCUs are widely used in embedded systems such as automotive controls, medical devices, appliances, and industrial automation.

2. PROBLEM STATEMENT

In existing EV's there is a need for automatic power transmission from secondary electrical components to electric motor in high altitude region.The problem occurs during climbing is affects the performance of the vehicle as well as the battery efficiency of the vehicle. In recent years the EV is developed and the running kilometers provide by the company is not achievable in practical basis because lots of issues and all electronic component need electricity to work, and this electricity is taken from the battery of the vehicle. But when vehicle is climbing hills, required more torque, so need to use more power for the motor. So to avoid this problem we develop the system which automatically switches off all electronic components which is not required to drive the vehicle.

1.2 ACTUAL PROBLEM IN VEHICLE

The air conditioner in a car draws power from the engine, mainly to run the air compressor. An AC system employs a refrigerant flowing through a compressor, condenser, expander and an evaporator. Air blows over the evaporator, where it is cooled and flown into the passenger cabin. So the AC system does use some of the fuel burnt in the engine. But that usage amount is very small in most modern cars. However in older cars, especially the ones with low engine power, continuously using the air-conditioner could reduce the mileage almost up to 20%.This mileage drop is even more prevalent when such cars go uphill with the AC turned ON. This is simply because, more load is put on the engine to move the vehicle against gravity.

3. OBJECTIVES

The objective of this project is to develop an Automated Secondary Load Reduction System for electric vehicles (EVs) to enhance torque availability during uphill driving. This system will:

1. Optimize Energy Usage – Identify and reduce non-essential electrical loads (e.g., air conditioning, infotainment, heating) when extra torque is required.

2. Improve EV Performance – Ensure smooth and efficient power delivery to the traction motor during steep inclines.

3. Enhance Battery Efficiency – Minimize unnecessary power consumption to extend driving range and battery life.

4. Develop an Intelligent Control System – Use gyroscopes, microcontrollers, and sensors to detect uphill conditions and dynamically adjust secondary loads.

5. Ensure Driver Comfort & Safety – Implement a gradual and automated load management system that does not disrupt the driving experience.4.

METHODOLOGY

The objective of this system is to optimize power distribution when a vehicle travels on inclined roads. As the vehicle ascends, the system automatically turns off the traveler's cooling fan to direct maximum power to the wheels. The fan's operation—its frequency and amplitude—adjusts based on the road's inclination angle. On steep slopes, the system ensures that most of the power is supplied to the wheels for efficient climbing. Conversely, on gentle slopes, only minimal extra power is directed to the rear wheels as needed.

This setup integrates a gyroscopic sensor into the vehicle's frame. When the vehicle begins ascending an inclined path, the sensor sends a signal to the microcontroller. The microcontroller is programmed to automatically cut off power to the fan, ensuring that maximum power is directed to the wheels. Additionally, a manual override allows the driver to disable this system, enabling power distribution to both the fan and the wheels as needed.

5. 2-D Diagram of CAD

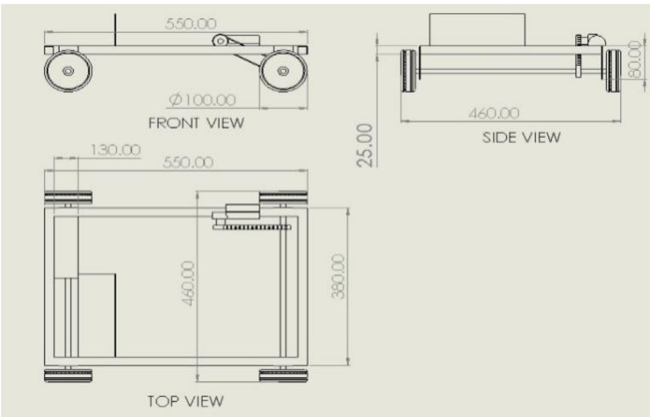

Figure 1: 2D Diagram (Model)

6. DESIGN OF THE PART USING CAD

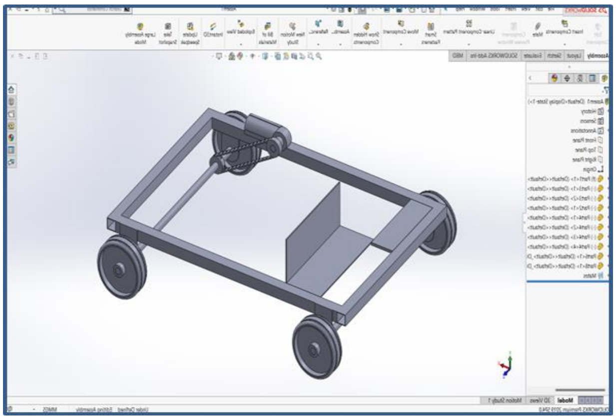

Figure 2: CAD Model 1

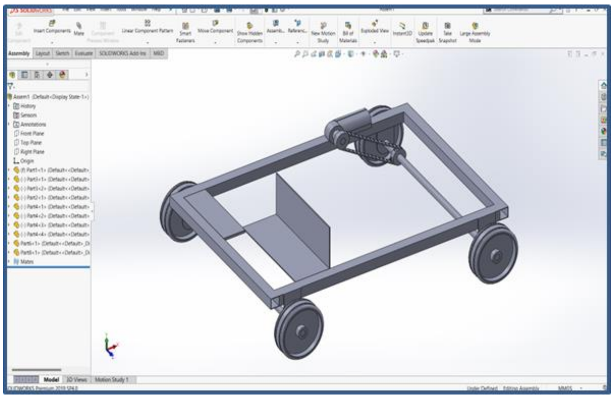

Figure 3: CAD Model 2

7. SPECIFICATION OF THE COMPONENTS

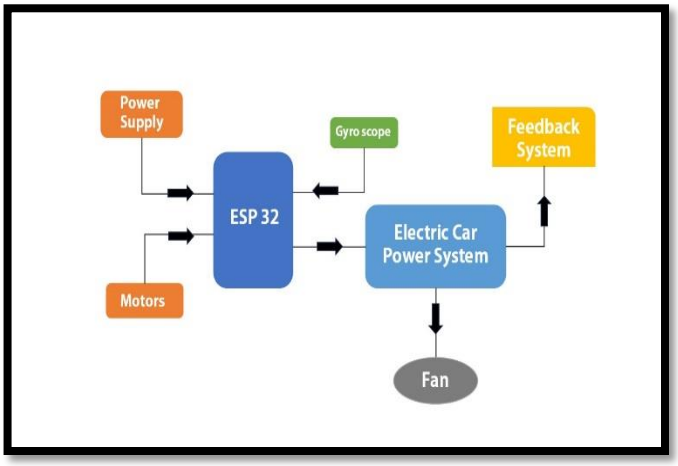

Figure 4: Block Diagram of System

1. **ESP32 Microcontroller**: The ESP32 microcontroller in this project detects uphill inclines using sensors. It measures the surface angle and gradient, analyzing the collected data to determine the slope accurately.

2. **Motor (Wiper Motor for Experimental Purpose)**: A windshield wiper motor is used in this setup for experimental purposes. It operates on a 12V DC power supply but can handle up to 13.5V. It rotates continuously, converting motion into a back-and-forth movement. In vehicles with a rear wiper, a separate motor powers it.

3. **Gyro Sensor**: Epson's motion sensors, including gyro sensors, detect movement in objects and people. These sensors measure rotation, orientation changes, and angular velocity using quartz elements. They are widely used in smartphones, cameras, game consoles, navigation systems, and robots. Various types exist, such as vibration, mechanical, and optical gyro sensors, each with different accuracy levels.

4. **Fan**: Included for demonstration purposes (A.C. fan).

5. **Battery**: Serves as the primary power supply.

6. **Feedback System**: An LED light acts as an indicator, signaling that the power generated by the system is being utilized by the motor.

8. CALCULATION

1. Required torque to move the frame

The motor rotate with the 5 kg of load at 55 rpm using a 4 inch tyre

Solution:-

1 inch =0.0254 m

4 inch =0.1016 m

Force required lifting the 18 kg load

F = m*a

= 5*9.81

=49.05 N

Torque required to moving operation

Torque = F*d

Torque = 49.05*0.1016

Torque = 4.9834 N-m

So, the torque required for moving operation is 4.98348 N-m

2. Torque of the wiper motor

Speed (rpm) = 55 rpm

Power (P) = 120 W

Torque = $\frac{60*P}{2*\pi*RPM}$

Torque = $\frac{60*120}{2*\pi*55}$

= $\frac{7200}{110\pi}$

Torque = 20.83 N-m

Torque required to moving the frame < Torque of the wiper

So, selected motor is safe.

9. CONCLUSION

1. This project introduces an automated power management system to enhance EV performance during uphill climbs.
2. It utilizes gyroscope sensors to detect inclines and automatically shuts off non-essential electrical components, redirecting power to the motor.
3. This improves torque, battery efficiency, and driving range, ensuring optimal performance in real-world conditions.
4. The system operates without manual input, providing a seamless and efficient driving experience.
5. By optimizing energy use on challenging terrains, this solution contributes to a more reliable and sustainable future for electric vehicles.

10. SCOPE OF PROJECT

1. **Research & Analysis –** Study existing EV energy management systems. Identify secondary loads and their impact on torque. Analyze torque demand variations on inclines.

2. **System Design & Development –** Develop an uphill detection algorithm using sensors and powertrain data. Design a load prioritization system to optimize energy usage. Integrate the system with EV electronics using a CAN Bus and a microcontroller-based control unit.

3. **Performance Evaluation & Optimization –** Measure improvements in torque, energy efficiency, and battery performance. Optimize the system for different EV models and driving conditions.

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