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POWERTRAIN DESIGN OF ALL-TERRAIN VEHICLE (ATV) USING Continuously Variable Transmission (Cvt)

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ABSTRACT :

The powertrain is the heart of an All-Terrain Vehicle (ATV), directly affecting its performance, reliability, and terrain-handling capability. This research focuses on the design and development of an efficient ATV powertrain utilizing a Continuously Variable Transmission (CVT) system. A Suzuki Access 125cc engine is integrated with a CVT and connected to the rear wheels through a chain and sprocket mechanism. The design emphasizes smooth power delivery, lightweight construction, and ease of maintenance. The proposed system is analyzed for torque transmission, efficiency, and dynamic behavior. Simulation results confirm that the CVT-based powertrain offers enhanced torque adaptability and seamless acceleration, ideal for off-road applications.

1. Introduction

All-Terrain Vehicles (ATVs) are designed for rugged environments, requiring a robust powertrain system capable of delivering high torque and smooth acceleration. Traditional manual transmissions are complex and reduce efficiency in variable terrain conditions. A CVT offers a simpler, automatic solution that continuously adjusts gear ratios, enhancing performance and drivability. This research investigates the development of an ATV powertrain incorporating a CVT, focusing on design, integration, and performance.

2. Objectives

- To design an efficient and reliable powertrain system for an ATV using a CVT.
- To evaluate the torque transmission capability and performance characteristics.
- To integrate the CVT with a 125cc engine and a chain-sprocket final drive.
- To analyze the system for efficiency, durability, and suitability in off-road applications.

3. Literature Review

Prior studies have shown that CVT-based powertrains offer better performance for small engine vehicles due to their ability to maintain optimal engine RPM. Research from SAE Baja events supports the use of scooter-based engines and CVT systems due to their availability and ease of integration. Chain and sprocket drives are commonly used for final drive due to simplicity, adjustability, and efficiency.

4. Design Specifications

- **Engine:** Suzuki Access 125cc, Air-cooled, 4-stroke, Single-cylinder.
- **Transmission Type:** CVT (with primary pulley, secondary pulley, and V-belt).
- **Final Drive:** Chain and Sprocket mechanism.
- **Drive Shaft:** Connected from CVT output to rear differential (or axle).

5. Methodology

1. **Engine Mounting and CVT Alignment**
    - Engine placed near the center of gravity for balanced weight distribution.
    - CVT pulleys aligned with proper belt tension and angle.
2. **Gear Ratio Calculation**
    - CVT Range: 0.5 (min) to 2.5 (max)
    - Final Sprocket Ratio: Primary (Engine) Sprocket = 14T, Secondary (Axle) Sprocket = 38T
    - Overall Drive Ratio = CVT Ratio × Sprocket Ratio
3. **Torque Transmission Calculation**
    - Engine Max Torque: 10 Nm at 5500 RPM
    - Effective Torque at Wheel = Engine Torque × Total Gear Ratio × Transmission Efficiency
4. **Simulation and Analysis**
    - CAD modeling using SolidWorks
    - FEA and motion simulation using ANSYS and MATLAB Simulink for dynamic behaviour

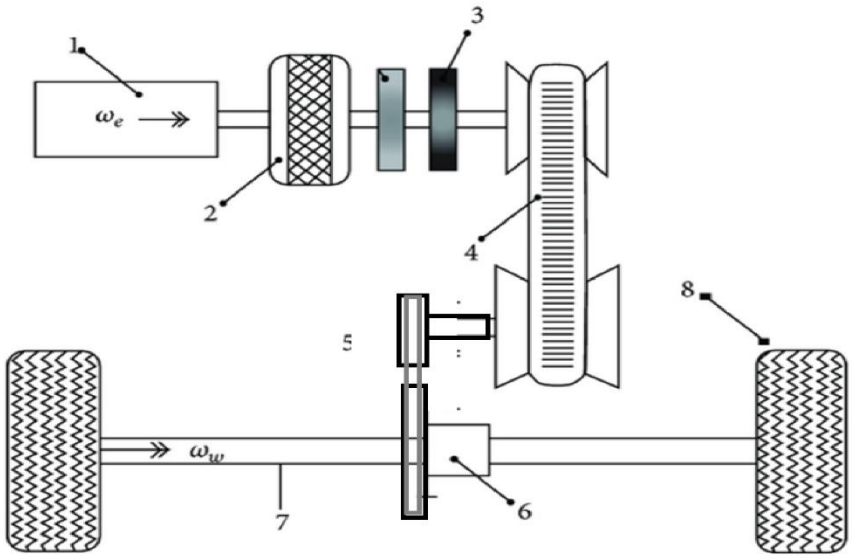
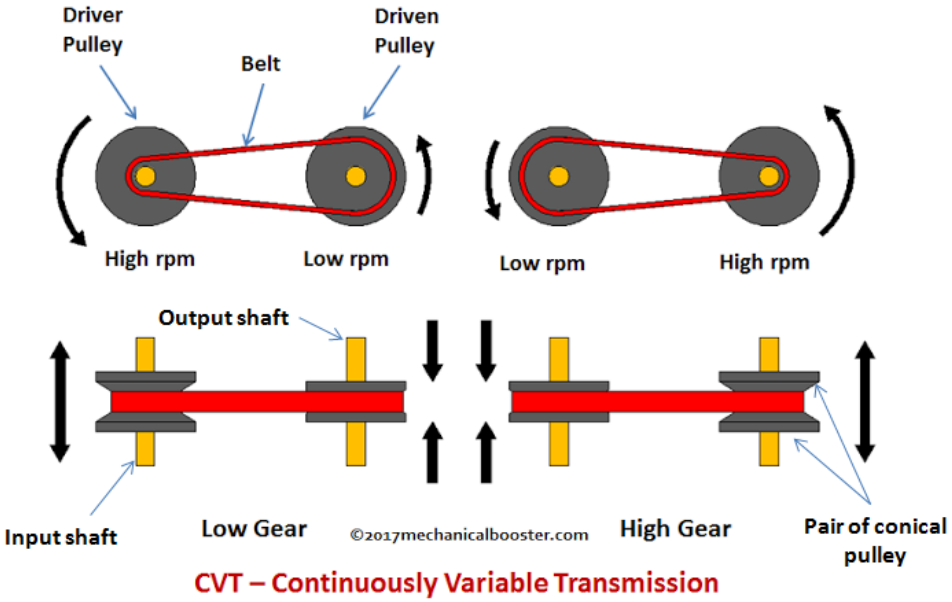


Fig. Power train

6. Results and Analysis

Parameter	**Value**
Max Engine Torque	10 Nm @ 5500 RPM
CVT Ratio Range	0.5 – 2.5
Sprocket Ratio	14T / 38T = 0.368
Overall Max Gear Ratio	2.5 × 0.368 = 0.92
Wheel Torque (Max Gear)	10 × 0.92 = 9.2 Nm (approx)
Efficiency (Est.)	85–90%
Max Vehicle Speed	~50 km/h (based on wheel size and RPM)



- **Observation:** The system delivers smooth torque transmission and adapts to terrain gradients without gear shifting, improving drivability.

7. Advantages of CVT Powertrain

- Smooth, gearless operation
- Continuous power delivery without shift shock
- Lightweight and compact compared to geared systems
- Easy to tune for desired performance

8. Challenges

- CVT belt slippage under high loads
- Heat generation and belt wear
- Limited torque handling compared to manual gear systems

9. Conclusion

The CVT-based powertrain designed for this ATV provides a smooth and efficient drive, ideal for off-road conditions. The Suzuki Access 125cc engine, when combined with a CVT and chain-sprocket drive, offers sufficient torque and reliability for ATV applications. The results suggest that this configuration enhances vehicle performance while simplifying the driving experience. Future scope includes implementing torque converters or electronically controlled CVT systems for advanced applications.

10. Future Scope

- Implementation of automatic CVT tuning using sensors.
- Integration with electric hybrid systems.
- Use of reinforced belts or pulleys for higher torque applications.

11. REFERENCES

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