

ANALYSIS OF ENERGY GENERATION THROUGH SUSPENSION

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Abstract

This project aim is to design and analysis of energy generation through suspension ,using friction motor as a increase in speed of the rotation movement created by the leverage of the suspension .This project is a easy and most efficient way of generating power through suspensions in vehicles(OCL) .It uses the leverage of the up and down motion of the suspension to generate electricity with set of spur gears and rack gear,which is further used for the other electrical systems in the vehicle and to boost their performance while the vehicle is in motion . A dynamo is an electrical generator that creates direct current using a commutator(UML). Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric- power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. A gear or gearwheel is a rotating machine part typically used to transmit rotational motion and/or torque by means of a series of teeth that engage with compatible teeth of another gear or other part.

Keywords: (OCL), (UML).

I. INTRODUCTION

The DYNAMO project is concerned with the high-assurance assembly of software components. A component1 is a self-contained unit of computation capable of interacting with its environment by reacting to events, providing requested services, and managing its state.

High-assurance is provided when a set of components, each of which acts according to its specification, results in a system that conforms to its specification. Specifications are expressed using the Object Constraint Language (OCL) a part of the industry-standard Unified Modeling Language (UML). DYNAMO specifications describe invariant relationships among the states of an assembly's components. An invariant is a system property expressed in terms of the externally visible elements of its components' states.

When an assembly receives an event from its environment, the state of one or more component can be altered. If that element of state is part of an invariant with other components, then it is necessary for those other components to be informed so that they might take steps to reestablish the invariant. This process is called invariant maintenance

2. Literature Review

Several researchers have studied the design and analysis of energy generation through suspension S.Mahendran et al (2014), A rigging wheel was designed to investigate the weight reduction and appropriation of tension for cast steel and composite materials.

Dighi et al. (2014), In light of the low cost of material assembly, lightweight and calm operation contrasted and metal riggings, they unveiled their work on polymer and polymer composite systems that found expanding use. By and large thermoplastic polymers like acetal polymer and nylon polymer are utilized for gear applications. Be that as it may, acetal and nylon gears have low burden conveying limit.

3. System Selection and Concept Development

Based on the literature review, a suitable energy harvesting mechanism is selected. Common approaches include:

- Electromagnetic suspension system (generator + coil + magnet)
- Hydraulic system with turbine generator
- Piezoelectric materials integrated into suspension

3.1 Design Approach

The design approach for energy generation using a vehicle suspension system focuses on converting mechanical vibrations into usable electrical energy while maintaining ride comfort and suspension performance.

3.2 Theoretical Analysis

Mathematical equations governing compressible flow are used to calculate:

E = induced voltage

NNN = number of turns

Φ = magnetic flux Modeling

The geometry is created using SOLIDWORKS software based on calculated dimensions.

3.3 Meshing

The model is discretized into finite volumes using ANSYS meshing tools.

3.4 Structural Analysis

The deformation is simulated using ANSYS Fluent with appropriate boundary conditions.

3.5 Validation

Results from Structural analysis are compared with theoretical values.

4. Spring Design Parameters

Parameter	Value
Total Spring Length	150 mm
Spring Diameter	53 mm
Pitch Distance	7.2 mm
Teeth Length	70 mm

The area ratio of the spring determines the load induced in the gears. Using the design parameters, the calculated area ratio resulted in an load of approximately 4.69 N, indicating required load to generate the required amount of rotation

THEORITICAL CALCULATIONS

A vehicle suspension can be modeled as a **spring-mass-damper system**, where road disturbances create oscillations:

$$m\ddot{x} + c\dot{x} + kx = F(t)$$

Where:

- m = mass of vehicle
- c = damping coefficient
- k = spring stiffness
- x = displacement
- $F(t)$ = excitation force due to road profile

5. Structural Analysis

The Structural simulation was carried out using ANSYS Fluent. A density-based solver was used because the load induced in the spring involves compressible high-speed dynamics.

The mesh was generated using structured elements to improve numerical accuracy. After meshing, boundary conditions such as load induced ,NO. of rotations and wall boundaries were applied. The simulation was run for multiple iterations until convergence was achieved

6. Boundary Condition

The mesh was checked in fluent software as already discussed. And then the next process is carried out which is giving boundary conditions. The values mentioned in the below table are referred and given as boundary condition.

Unit System	Metric (mm, kg, N, s, mV, mA) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

7. Results and Discussion

Model (A4) > Coordinate Systems > Coordinate System

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0.

Origin	
Origin X	0. mm
Origin Y	0. mm
Origin Z	0. mm
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

8.CONCLUSION

This paper presented HSAMS, an IoT-based hierarchical solar array monitoring system delivering panel-level fault detection at This study presented the design and The amount of load that the device can withstand by the device during the working can be obtained which helps in improvement of the material and working of the device that further used to increase the amount of energy generation efficiently

The study shows that the performance of such systems largely depends on key parameters including spring stiffness, damping characteristics, vibration amplitude, and road excitation conditions. Optimized design of the suspension system allows a balance between energy harvesting efficiency and ride comfort, which is critical for practical implementation.

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