Proposal of Linear Oscillatory Actuator Using DC Motor for Active Control Engine Mount

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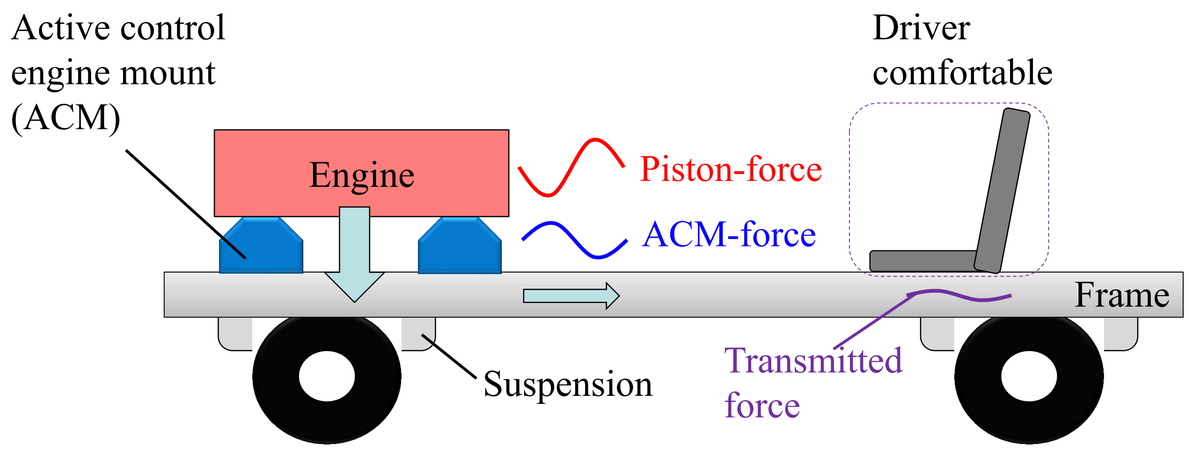
Introduction

- Recently, Active Control Engine Mounts (ACMs) using Linear Oscillatory Actuators (LOAs) have been mounted underneath automobiles to reduce frame vibrations and noise.
- ACMs are mounted only in expensive automobiles because they are costly.

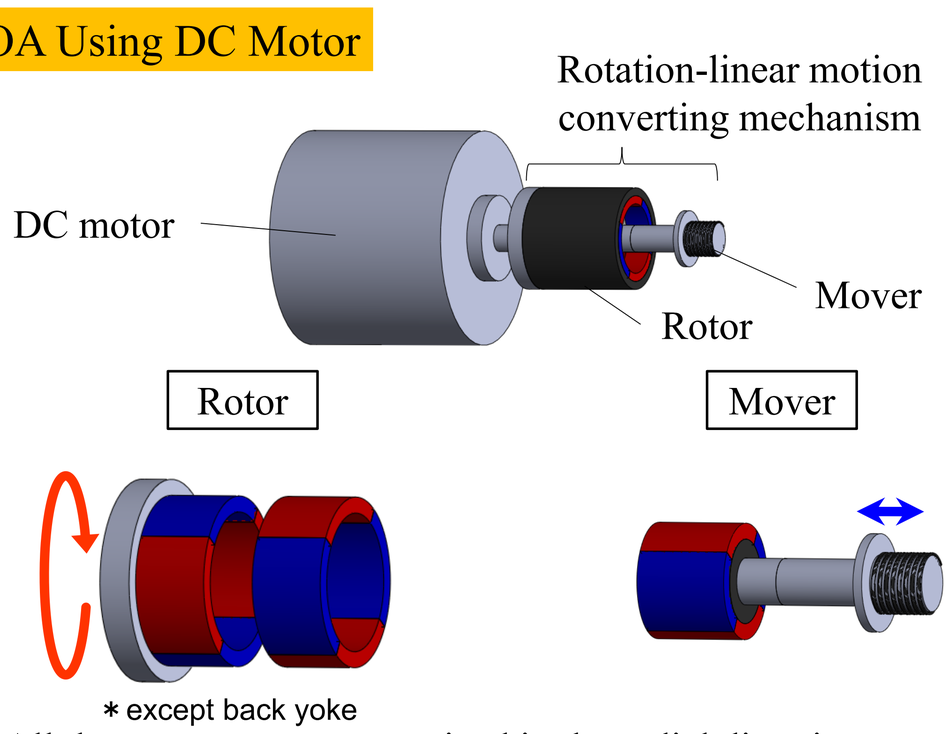
We proposed a new LOA using a brushed DC motor. It was assumed that ACMs using this actuator would be low cost because brushed DC motors can be easily mass produced and the control method has already been established.

Active Control Engine Mount (ACM)



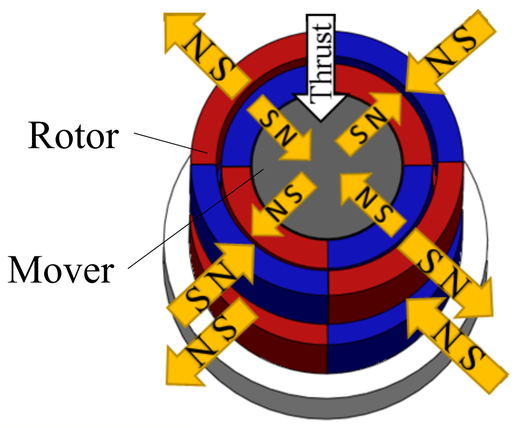
Proposed Actuator

LOA Using DC Motor



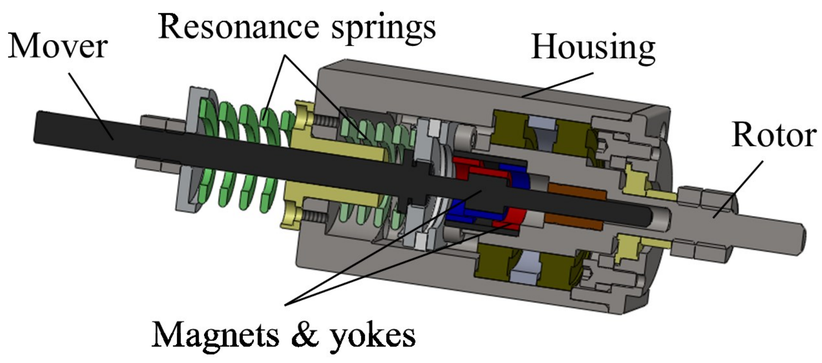
- All the magnets are magnetized in the radial direction.
- The mover is fixed so that it cannot rotate but can only move in the axial direction.

Operating Principle



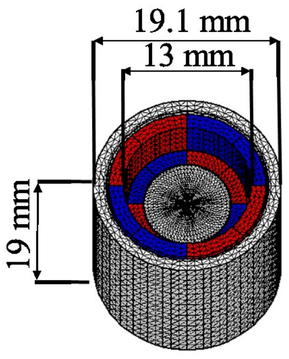
- In the case of the left figure, the repulsive force is generated in the upper part and the attractive force in the lower part, so the mover is forced to move downward.
- Since the magnetizing direction of the upper and lower array of magnets in the rotor are opposite to each other, the mover linearly oscillates when the rotor is rotated.

Prototype



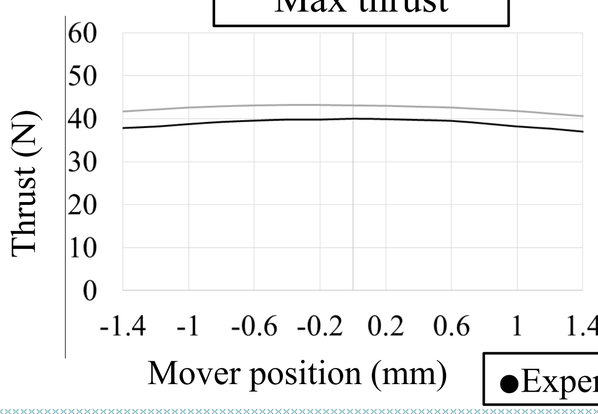
Static Characteristics

Mesh model

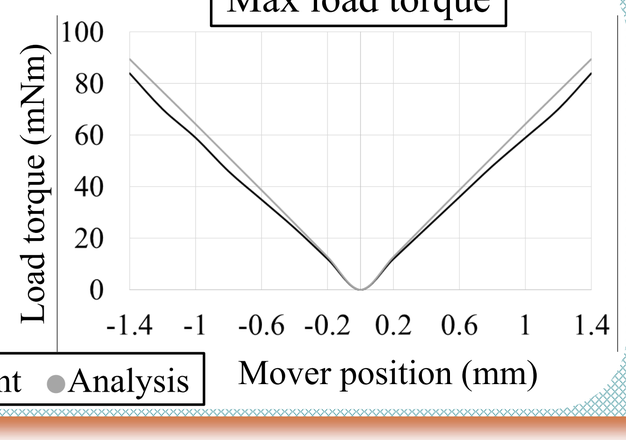


- The static characteristics are verified by FEM and experiments on the prototype.
- The static thrust and the load torque results by experiments are in good agreements with those by analysis.

Max thrust



Max load torque



●Experiment ●Analysis

Dynamic Characteristics

- The dynamic characteristics are verified through dynamic simulation by coupling FEM with MATLAB/Simulink and experiments on a prototype.
- The mover position and amplitude when the rotor are rotated forcibly is shown in the right.

20 Hz

40 Hz

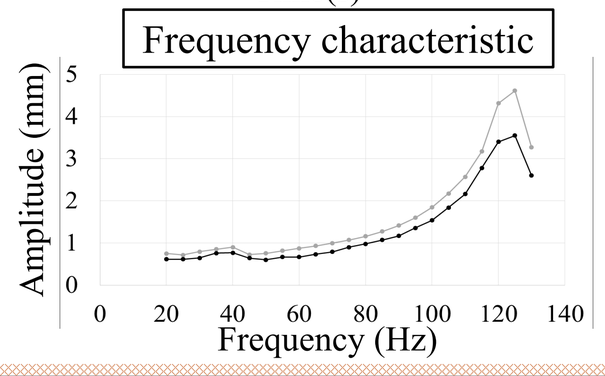
60 Hz

●Experiment ●Analysis

Motion parameter

Spring constant	57.5 N/mm
Mass of armature	95.75 g
Viscous damping constant	7.3 Ns/m
Dynamic friction force	3 N

Frequency characteristic



- All waveforms are good agreements.
- The cause of difference of amplitudes at high frequency is thought to be an eddy current.

Conclusion

- We proposed a new LOA which converts rotational motion into linear motion using DC motors.
- Through FEM analysis, dynamic simulation and experiments on a prototype, we verified the static and dynamic characteristics.
- In the future, this LOA will be integrated into the ACM, and the vibration damping characteristics will be investigated.