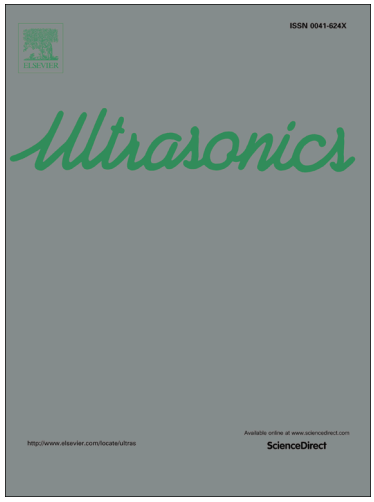

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Linear Ultrasonic Motor for Absolute Gravimeter

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ABSTRACT:

Thanks to their compactness and suitability for vacuum applications, linear ultrasonic motors are considered as substitutes for classical electromagnetic motors as driving elements in absolute gravimeters. Still, their application is prevented by relatively low power output. To overcome this limitation and provide better stability, a V-type linear ultrasonic motor with a new clamping method is proposed for a gravimeter. In this paper, a mechanical model of stators with flexible clamping components is suggested, according to a design criterion for clamps of linear ultrasonic motors. After that, an effect of tangential and normal rigidity of the clamping components on mechanical output is studied. It is followed by discussion of a new clamping method with sufficient tangential rigidity and a capability to facilitate pre-load. Additionally, a prototype of the motor with the proposed clamping method was fabricated and the performance tests in vertical direction were implemented. Experimental results show that the suggested motor has structural stability and high dynamic performance, such as no-load speed of 1.4 m/s and maximal thrust of 43 N, meeting the requirements for absolute gravimeters.

Key words: linear ultrasonic motor, absolute gravimeter, clamping method, design

1. Introduction

A precise knowledge of the magnitude of the Earth's gravitation field and its variation is crucial for various aspects of science and technology, [1-3]. It can be acquired with a high-precision absolute gravimeter and used for earthquake prediction, exploration of mineral resources and as essential reference for aircraft navigation and missile guidance.

The absolute gravimeter is regularly placed at different locations to observe the local geomagnetic field variations, so it is best to be light and portable, [4-5]. A free-fall absolute gravimeter assesses the level of gravity value by measuring the distance and time of a free fall of a body in vacuum. Such a device is designed to produce a stable and repeatable motion of a free-falling body, [6]. Traditional absolute gravimeters commonly use electromagnetic motors as driving device, which can lead to complicated and heavy structures. Electromagnetic motors are complex structures themselves and they need also mechanical transmission components to provide rectilinear motion directly. A linear ultrasonic motor as a replacement for an electromagnetic motor as the driving device could provide a rectilinear motion directly in the vacuum without transmission components, simplifying the instrument and making it