The Study of Using Shape Memory Alloy Suspension Springs in the Vibration Reduction of Optical Disk Drive

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ABSTRACT

The ever increasing demand on the higher read/write speed of the optical disk drive imposes a continuous challenge to the design engineers. Although the state-of-art technique of ball-balancer mechanism can effectively reduce the vibration of the platform due to the inherent imbalance of the commercial optic disk drive, the design performs stably its function only at rotation speed above the natural frequency of the platform. For ordinary optical disk drive, the reading speed is usually several folds higher that of writing mode. Therefore, it is difficult, if not impossible, to have the platform designed in suitable dynamic characteristics for the requirement of the operational ball-balancer system. The introduction of semi-active vibration reduction system could offer a solution to the system both technically and economically. This study focused on the application of the controllable stiffness difference between the martensite and austenite phases of the shape memory materials. The suspension springs of the platform were constructed using this type of material. Hence, by controlling the temperature of the suspension springs the stiffness of the suspension and, consequently, the natural frequency of the platform can be tuned according to operation mode of the disk drive. This ensures that the ball-balancer mechanism will be stably operated no matter which mode of the disk drive is in. In the theoretical derivation, the spring constant of a helical spring subjected to transverse loading was formulated first using Castigliano ’ s Theorem. The derivation was justified by comparing the result with that of ANSYS. Then, the equations of motion of a platform with four suspension springs were derived employing Hamilton ’ s Principle. In the experimental study, the static and dynamic measurements of the single spring under various external loading were conducted. The results showed that the SMA spring used herein underwent a decrease-and-then-increase change in the spring constant when it was heated form room temperature to 90℃. A nearly 20% change in effective stiffness was observed. The measurements on the dynamic response of the platform demonstrated that the natural frequency could be tuned by controlling the heating and cooling of the SMA springs. However the range of the tuning was controlled by the number of active coils and other geometrical dimensions of the spring.

Keywords : Optical disk platform, semi-active vibration control system, shape memory alloy (SMA)

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